PROSPECTIVE STUDY OF FUNCTIONAL OUTCOME OF DISTAL RADIUS FRACTURE MANAGED BY MINIMALLY INVASIVE PLATE OSTEOSYNTHESIS

Dissertation Submitted to

THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY

in partial fulfillment of the regulation

for the award of

M.S. DEGREE IN

ORTHOPAEDIC SURGERY

BRANCH II

DEPARTMENT OF ORTHOPAEDICS

TIRUNELVELI MEDICAL COLLEGE

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

CHENNAI, INDIA

APRIL 2016

CERTIFICATE

This is to certify that this dissertation entilted "**PROSPECTIVE STUDY OF FUNCTIONAL OUTCOME OF DISTAL RADIUS FRACTURE MANAGED BY MINIMALLY INVASIVE PLATE OSTEOSYNTHESIS,** which is being submitted for M.S Orthopaedics, is a bonafide work of **Dr.P.Keerthivasan**., Post graduate student of the Department of Orthopaedics, Tirunelveli Medical College Hospital, Tirunelveli, during the academic year 2013 -2016.

DEAN

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Tirunelveli

CERTIFICATE

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He has completed the necessary period of stay in the department and has fulfilled the condition required for submission of this thesis according to university regulations. The study was undertaken by the candidate himself and the observations recorded have been periodically checked by us.

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CERTIFICATE

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Dr. M. SENTHIL KUMAR

Assistant Professor,

Department of Orthopaedics,

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DECLARATION

I, **Dr.P.Keerthivasan**., solemnly declare that this dissertation tilted "**PROSPECTIVE STUDY OF FUNCTIONAL OUTCOME OF DISTAL RADIUS FRACTURE MANAGED BY MINIMALLY INVASIVE PLATE OSTEOSYNTHESIS"** is a bonafide work done by me at Tirunelveli Medical College from August 2013 onwards under the guidance and supervision of **Prof.ELANGOVAN CHELLAPPA, M.S.ORTHO, D.ORTHO**, Professor and Head of the Department, Department of Orthopaedics, Tirunelveli Medical College, Tirunelveli.

I have not submitted this dissertation to any other university for the award of any degree or diploma previously. This dissertation is submitted to The Tamilnadu Dr. M.G.R. Medical University, Chennai towards partial fulfillment of the rules and regulations for the award of **M.S DEGREE IN ORTHOPAEDIC SURGERY (BRANCH – II).**

PLACE :

DATE : **Dr.P.KEERTHIVASAN**

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I am obliged to record my immense gratitude to **Dr.Sithy Athiya Munavarah, M.D**., Dean, Tirunelveli Medical College Hospital for providing all the facilities to conduct the study.

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My hearty thanks to all my beloved friends for their wishes and co-operation amidst their busy schedule throughout my study.

Last but not the least I am profoundly grateful to all the patients for their co-operation and participation in this study.

ETHICAL COMMITTEE CERTIFICATE

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CERTIFICATE OF REGISTRATION & APPROVAL OF THE TIREC REF NO: 511/ORTHO/2014/18

PROTOCOL TITLE: PROSPECTIVE STUDY OF FUNCTIONAL OUTCOME OF DISTAL RADIUS FRACTURE MANAGED BY MINIMALLY INVASIVE PLATE OSTEO SYNTHESIS.

NAME OF PRINCIPAL INVESTIGATOR: Dr. P.Keerthivasan, MBBS.,
DESIGNATION OF PRINCIPAL INVESTIGATOR: Post Graduate in MS Orthopaedics
DEPARTMENT & INSTITUTION: Department of Orthopaedics, Tirunelveli Medical College

Dear Dr. P.Keerthivasan, *The Tirunelveli Medical College Institutional Ethics Committee (TIREC) reviewed and discussed your application during the IEC meeting held on 14.05.14.*

THE FOLLOWING DOCUMENTS WERE REVIEWED AND APPROVED

1. TIREC Application Form ☐
2. Study Protocol ☐
3. Department Research Committee Approval ☐
4. Patient Information Document and Consent Form in English and Vernacular Language ☐
5. Investigator's Brochure ☐
6. Proposed Methods for Patient Accrual Proposed ☐
7. Curriculum Vitae of the Principal Investigator ☐
8. Insurance /Compensation Policy ☐
9. Investigator's Agreement with Sponsor ☐
10. Investigator's Undertaking ☐
11. DCGI/DGFT approval ☐
12. Clinical Trial Agreement (CTA) ☐
13. Memorandum of Understanding (MOU)/Material Transfer Agreement (MTA) ☐
14. Clinical Trials Registry-India (CTRI) Registration ☐

THE PROTOCOL IS APPROVED IN ITS PRESENTED FORM ON THE FOLLOWING CONDITIONS

1. The approval is valid for a period of 2 year/s or duration of project whichever is later
2. The date of commencement of study should be informed
3. A written request should be submitted 3weeks before for renewal / extension of the validity
4. An annual status report should be submitted.
5. The TIREC will monitor the study
6. At the time of PI's retirement/leaving the institute, the study responsibility should be transferred to a person cleared by HOD
7. The PI should report to TIREC within 7 days of the occurrence of the SAE. If the SAE is Death, the Bioethics Cell should receive the SAE reporting form within 24 hours of the occurrence.
8. In the events of any protocol amendments, TIREC must be informed and the amendments should be highlighted in clear terms as follows:
   a. The exact alteration/amendment should be specified and indicated where the amendment occurred in the original project. (Page no. Clause no. etc.)
   b. The PI must comment how proposed amendment will affect the ongoing trial. Alteration in the budgetary status, staff requirement should be clearly indicated and the revised budget form should be submitted.
   c. If the amendments require a change in the consent form, the copy of revised Consent Form should be submitted to Ethics Committee for approval. If the amendment demands a re-look at the toxicity or side effects to patients, the same should be documented.
   d. If there are any amendments in the trial design, these must be incorporated in the protocol, and other study documents. These revised documents should be submitted for approval of the IEC, only then can they be implemented.
   e. Approval for amendment changes must be obtained prior to implementation of changes.
   f. The amendment is unlikely to be approved by the IEC unless all the above information is provided.
   g. Any deviation/violation/waiver in the protocol must be informed

STANDS APPROVED UNDER SEAL

14/10/14

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Registrar, TIREC	**Member Secretary, TIREC**
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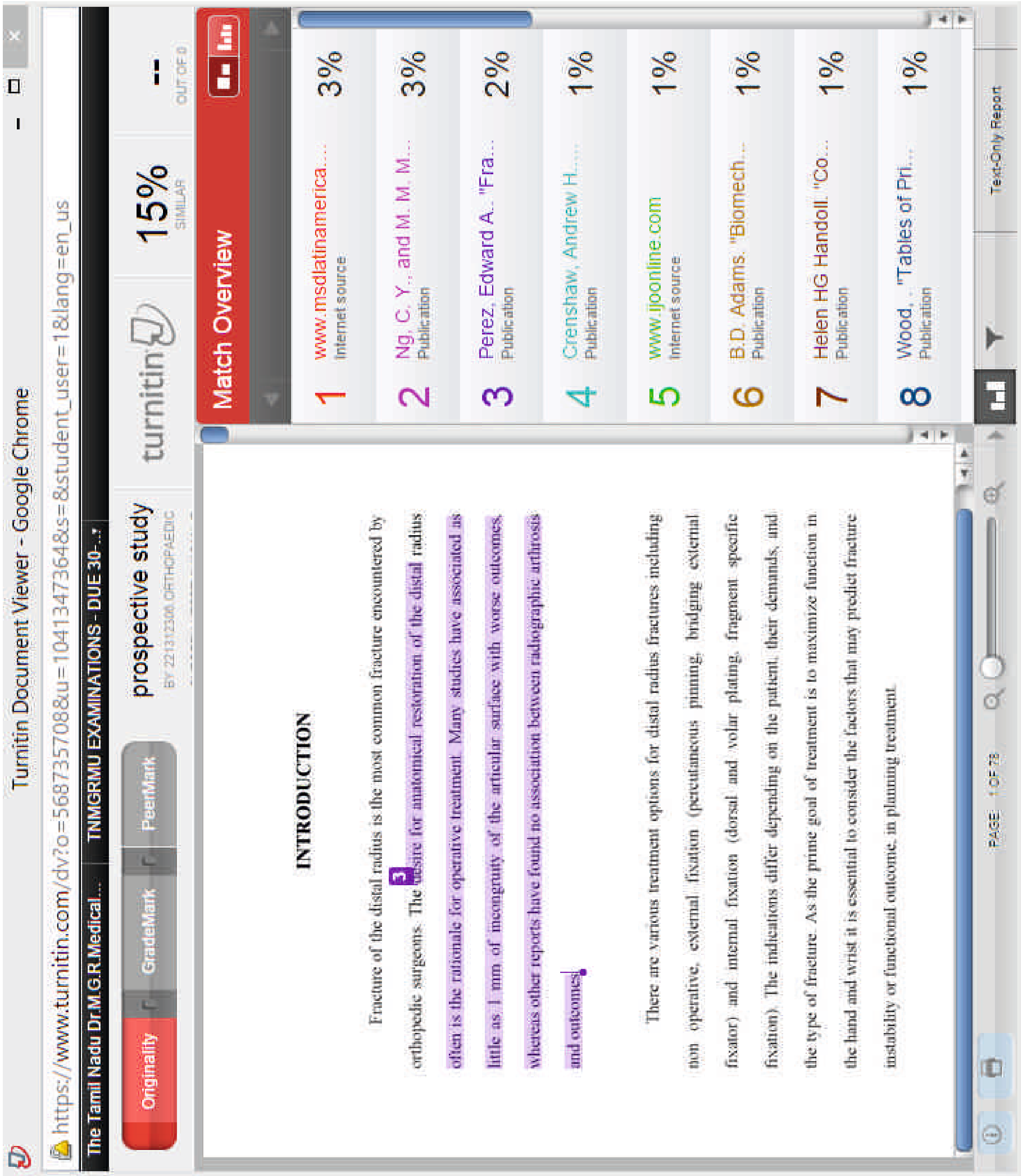
PLAGIARISM CERTIFICATE



CONTENTS

INTRODUCTION

Fracture of the distal radius is the most common fracture encountered by orthopedic surgeons. The desire for anatomical restoration of the distal radius often is the rationale for operative treatment. Many studies have associated as little as 1 mm of incongruity of the articular surface with worse outcomes, whereas other reports have found no association between radiographic arthrosis and outcomes.

There are various treatment options for distal radius fractures including non operative, external fixation (percutaneous pinning, bridging external fixator) and internal fixation (dorsal and volar plating, fragment specific fixation) . The indications differ depending on the patient, their demands, and the type of fracture. As the prime goal of treatment is to maximize function in the hand and wrist it is essential to consider the factors that may predict fracture instability or functional outcome, in planning treatment.

In conventional plating, there is more soft tissue dissection including stripping of pronator quadratus which may lead to post-operative pain and scarring, and impede the range of motion. The deep head of pronator quadratus is a dynamic stabiliser of distal radio ulnar joint. Further the blood supply from the pronator quadratus is also disrupted which may lead to avascularity of articular fragments and delay fracture healing.

In minimally invasive plate osteosynthesis, the soft tissue dissection is limited and the implant is slid under intact pronator quadratus. The biomechanical advantages of soft tissue is left undamaged. Besides, the mini incision provides better cosmetic results. Hence the technique of MIPO can be utilised for extra articular and simple type of intra articular fractures of distal radius.

HISTORICAL REVIEW

467-300 BC : Hippocrates diagnosed distal radius fracture as dislocation of wrist

1783 : Pouteau described this fractures

1814 : Abraham colles clinically diagnosed and treated with closed manipulation

1847 : Barton described anatomy of Colles fracture

1850 : Mathjrem described Plaster application

1898 : Beck & Cottan described displacement pattern

1908 : First pinning for Radial styloid fractures

1928 : Bohler published his results using reduction by Longitudinal fixed traction

1934 : Anderson used External fixators

1939 : Nissen – Lie classification system introduced

1951 : Gartland & Werely classification system published

1965 : Ellis used buttress plates for Barton's fractures

1967 : Frykman introduced classification system

1975 : Stein &Katz modified pinning technique

1976 : Lorttaxt & Jacob described radial styloid pinning & fixation of posteromedial fragment

1976 : Kapandji introduced intra focal pinning technique

1978 : Jaques vidal coined Ligamentotaxis

1984 : Melone introduced classification

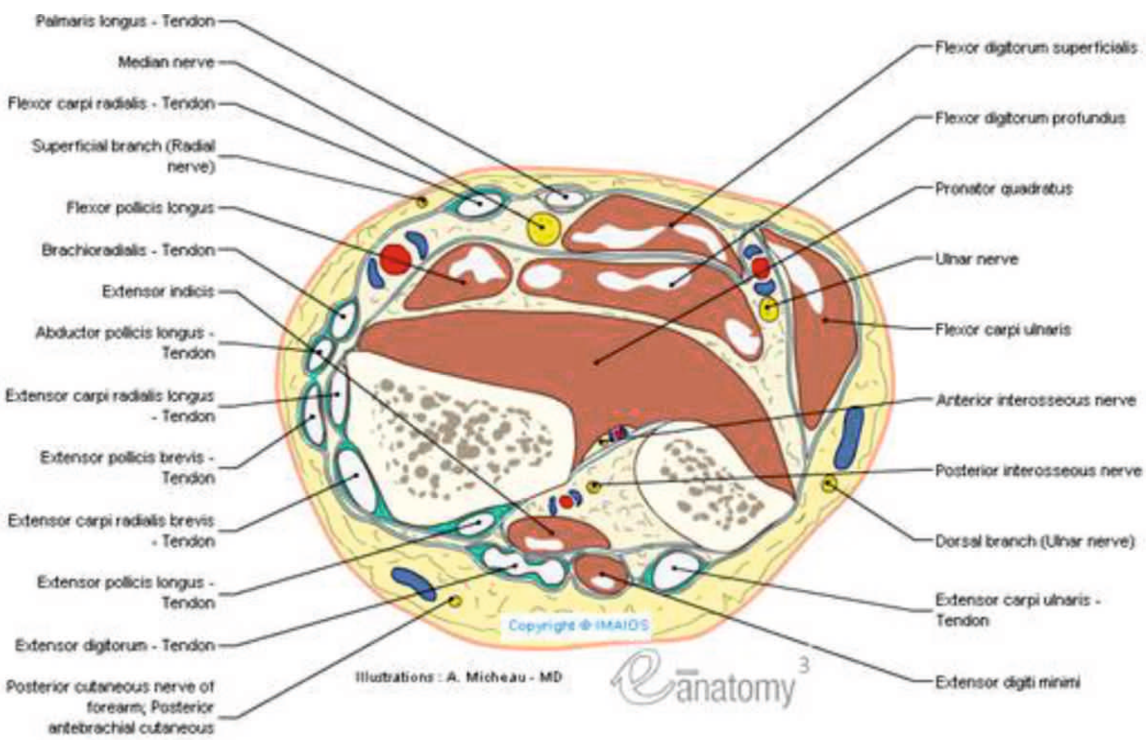
1990 : Lc-Dcp introduced

1993 : Mayo introduced his classification

2000 : Locking compression plates introduced

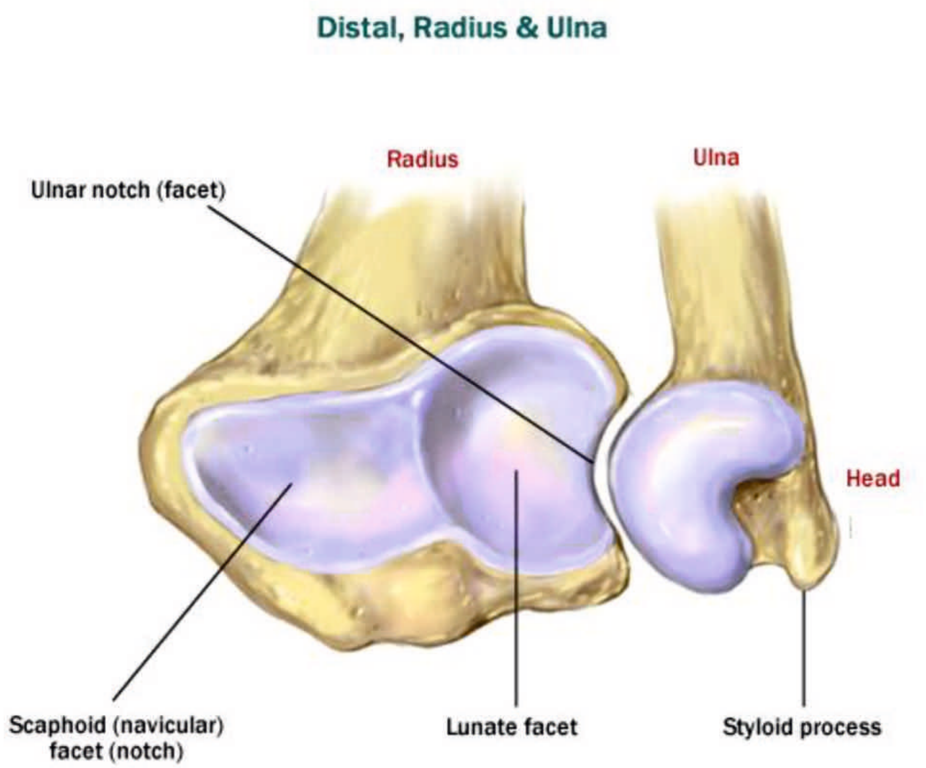
ANATOMY

The distal end of the radius and ulna is an integral part of the wrist joint and restoration of its normal anatomy is necessary for the mobility of the wrist and its ability to transmit axial load. The main function of the wrist joint is to maintain hand position and allow full hand function. Thus fractures of the distal radius that malunite are likely to have a detrimental effect on hand function.

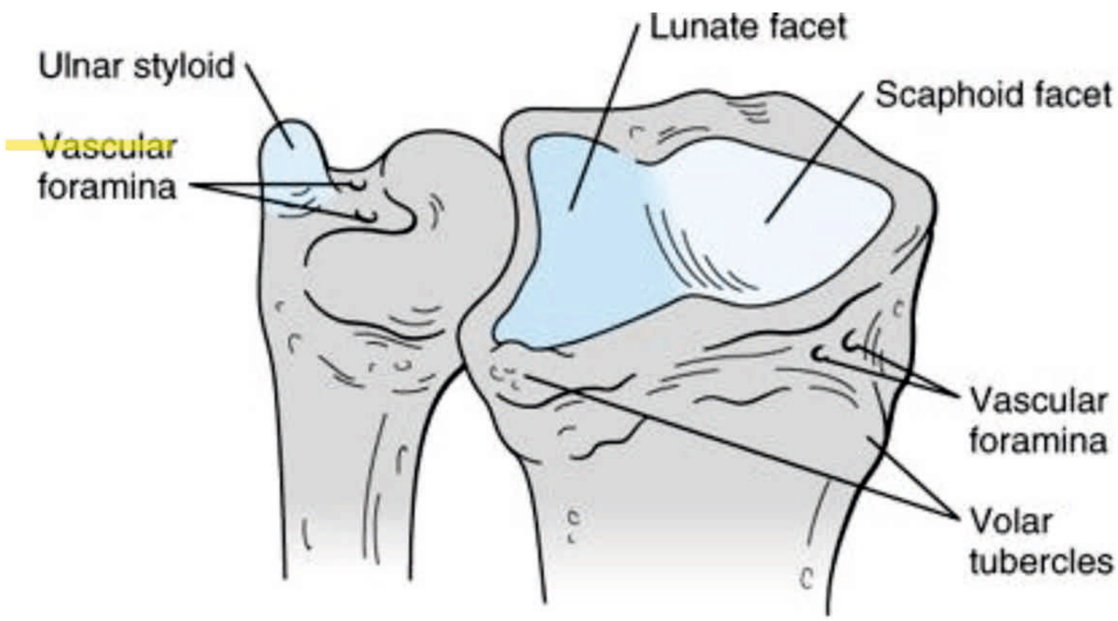


The articular surface of the distal radius has two concavities, one for articulation with the scaphoid and one for the lunate. These two facets are divided by a ridge running from dorsal to volar. The surface is triangular in shape with the base formed by the sigmoid notch and the apex by the tip of the radial styloid. The articular surface is inclined both in a volar and an ulnar direction.

The palmar surface of the radius forms a curve concave from proximal to distal. It is relatively smooth, which allows easy contouring of plates in this area. It also allows attachment of stout radiocarpal ligaments, which act as restraints to the normal tendency of the carpus to slide in an ulnar and palmar direction. The curve is covered by the transverse fibers of pronator quadratus, which is attached to the radial side of the bone.



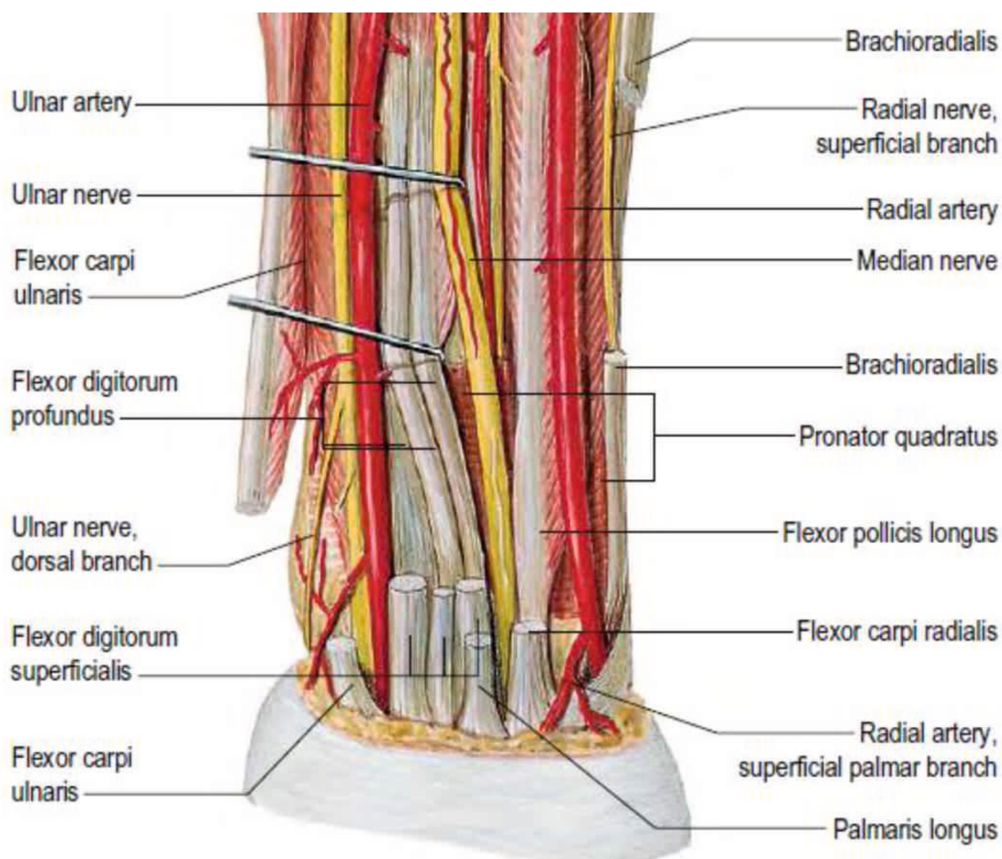
The dorsal surface is convex and much more irregular with Lister's tubercle, around which the extensor pollicis longus (EPL) tendon passes, being the most prominent area. There are grooves that form the floors of extensor compartments.



The distal radius forms one half of the distal radioulnar joint, the sigmoid notch, which is a uniform curve semi-cylindrical in shape allowing rotation of the radius around the ulnar head. As rotation occurs the ulnar head moves in a volar direction with supination and a dorsal direction with pronation. The ulnar head is largely covered in cartilage even on its inferior surface. However, it does not articulate with the carpus as the TFCC extends from the ulnar aspect of the radius to the base of the ulnar styloid and articulates with the triquetrum.

The TFCC acts as a stabilizer of the distal radioulnar joint along with extensor carpi ulnaris and flexor carpi ulnaris, the interosseous membrane of the forearm and the pronator quadratus.

The pronator quadratus, flat square shaped muscle originates from linear ridge on anterior surface of lower end of ulna and passes laterally to insert onto the flat anterior surface of the radius. It lies deep to the tendons of flexor digitorum profundus and flexor pollicis longus muscles. It is innervated by the anterior interosseous nerve and supplied by corresponding artery.

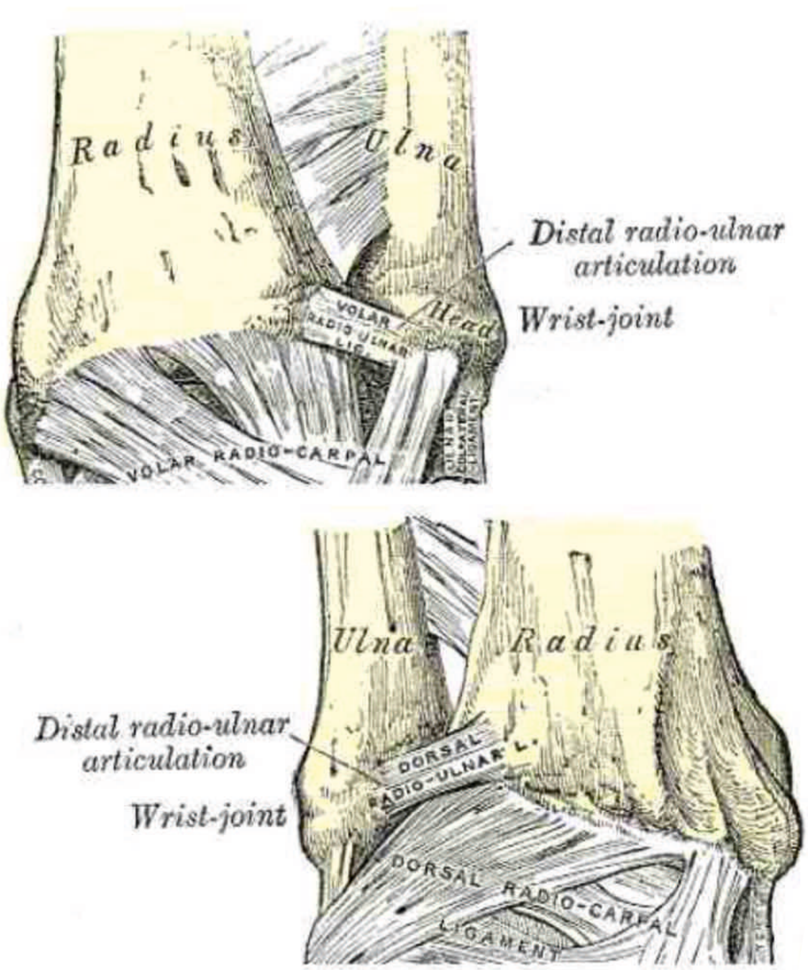


Supporting ligaments arising from dorsal surface include

1. Radioscaphoid ligament

2. Radio triquetral ligament

Ligaments of distal radius



Ligaments arising from palmar aspect

1. Radial collateral ligament

2. Radiocapitate

3. Radiotriquetral

Triangular fibro cartilage complex:

TFCC extends from radial styloid notch to styloid process of ulna. The thickened dorsal and volar margins of Triangular fibro cartilage comp lex became the dorsal and volar radioulnar ligaments.

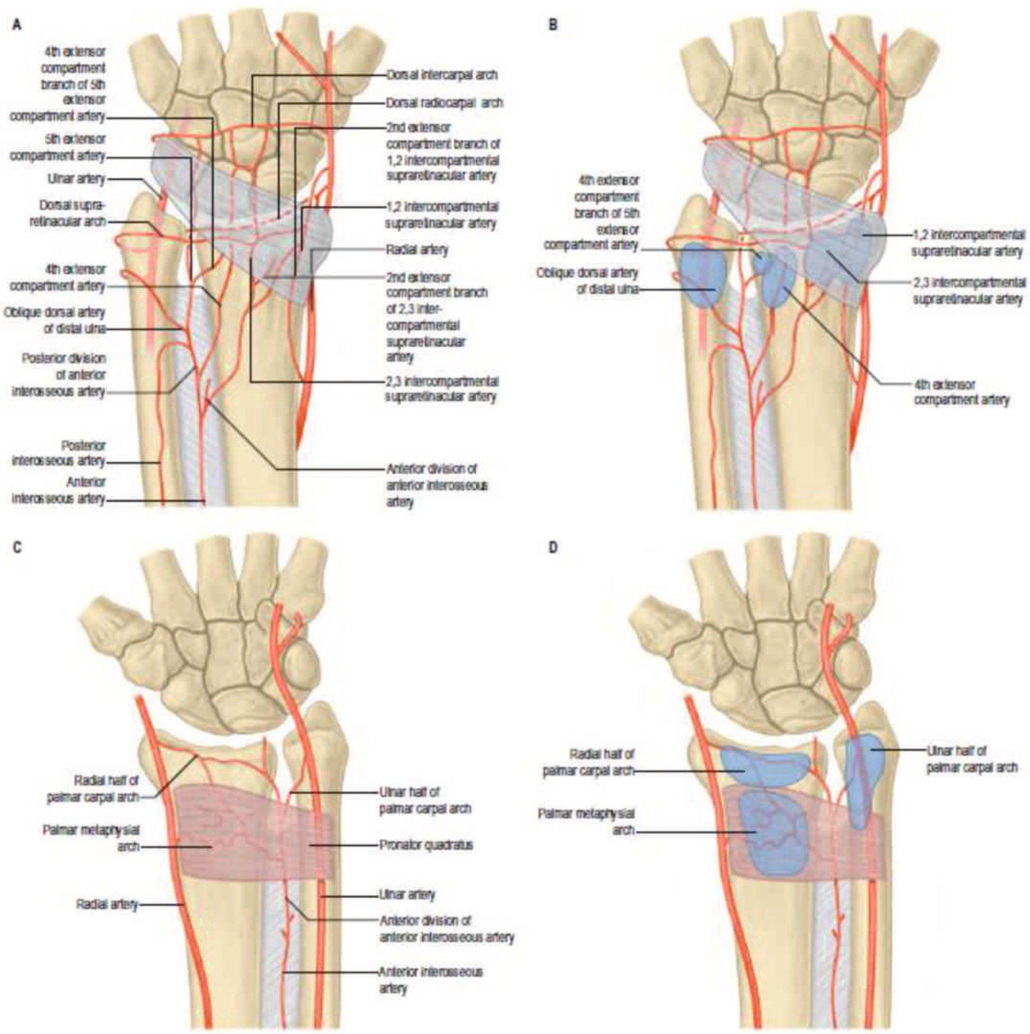
The smooth articular unit of lunate, scaphoid and triquetrum which is in contact with the distal radius and TFCC is maintained by the interosseous, the scapholunate and the lunotriquetral ligaments in addition to the extrinsic ligaments of the wrist.

The only tendon to have its insertion on the distal radius is that of brachioradialis. However other flexors and extensors of the wrist have their insertion on the carpal bones and the metacarpal bases only after passing across the distal radius.

VASCULAR SUPPLY

It is mainly from anterior interosseous artery and radial artery. The ulnar artery& posterior interosseous artery are involved only indirectly via the anastomosis between the carpal arteries. As for all long bones the vascularity arises from three sources, mainly nutrient artery, metaphyseal artery and periosteal plexus.

Anterior interosseous artery plays important role and mainly covers anterior and medial aspect of distal radius. Radial artery supplies the posterolateral aspect and lateral part of anterior aspect of distal radius. Small musculoperiosteal branches arise distal to pronator teres from radial artery to supply the FPL & Pronator quadratus. These branches pass across the radial attachments of muscles to vascularise the postero and anterolateral aspect of radius and communicates with the musculoperiosteal branches of anterior interosseous artery.



BIOMECHANICS OF DISTAL RADIOULNAR JOINT

Anatomically, the ulna is stable axis of rotation of the forearm around which the radius moves.If there is a dislocation , it is technically the radius that displaced dorsally or palmarly with respect to the ulna.The distal radioulnar joint has both rotational and translational components of motion and does not have a single center of rotation.Four structures play main role in stabilizing the distal radio ulnar joint in different positions of forearm rotation. They are

1. Dorsal radioulnar ligaments
2. Palmar radioulnar ligaments
3. Pronator quadrates
4. Interosseous membrane

The palmar ligaments become maximally tightened and stabilize the joint in forearm supination, whereas the dorsal ligaments become maximally tightened and stabilize the joint in forearm supination.

Fractures involving the distal radioulnar joint and the distal radius change the biomechanics of the triangular fibro cartilage complex. Incongruency of distal radio ulnar joint results with increasing dorsal tilt of distal radius. Dorsal angulation limits forearm rotation.

Compression and axial loading across the wrist are primarily transmitted to distal radius, but the force is partially transmitted through the triangular fibro cartilage complex to the ulna head. As ulnar length increases from -2.5 to+2.5 mm, the load borne by distal ulna increases from 4% to 42%.

REVIEW OF LITERATURE

Ombredanne in 1929, reported external fixation of the distal radius. Roger Anderson and Gordon O'neill in 1944 introduced bridged external fixation to address the poor results of non-operative management. The external fixator had undergone various modifications in mechanics and fixation level to facilitate manipulation and ligamentotaxis.

Percutaneous pinning with a single radial styloid pin as suggested by Lambotte in 1907 dominated the methods of internal fixation for a long period. Later multiple pinning was reported in middle to late 20^{th} century.

Plating was first popularised by Ellis in 1965. Recently many advancements have been evolved in dorsal and volar plating techniques.

The outcome of fracture depends upon integrity of soft tissues. The advantage of soft tissue preservation with MIPO is being utilised in various fractures. The same principle applies to distal radius as well with recent literatures reporting improved functional outcome and fracture healing in distal radius fractures treated with minimally invasive techniques.

CLASSIFICATION

Numerous classification systems have been proposed for fractures of distal radius and ulna, the majority of which are morphologic and consider in varying degrees the presence or absence of displacement, comminution, and articular involvement. The older classification systems still quoted are Gartland and Werley and the Frykman classification, with the Melone classification for intraarticular fractures.

In 1951, **Gartland and Werley** described a classification system considering articular involvement, displacement and comminution.

GROUP	CHARACTERISTIC FEATURES
I	Simple colles fracture with no articular involvement
II	Comminuted colles fracture,with undisplaced fragments of the articular fracture
III	Group II with articular fragments displacement

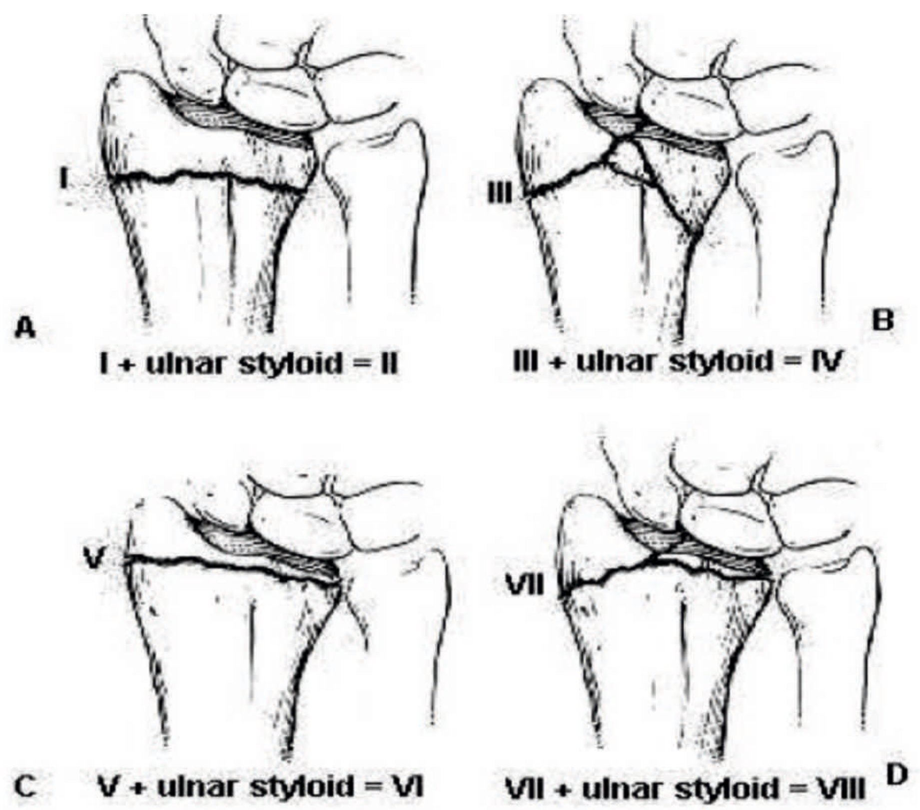
Group 4—Gartland and Werley did not specify whether group 1 fractures were displaced or not but Solgaard added this fourth group of extra-articular undisplaced fractures.

Older classification:

Type	Characteristics
I	Nondisplaced, length of radial styloid ≥7 mm, dorsal angulation ≤5°.
II	Displaced with minimal comminution of dorsal radius, length of radial styloid <7 mm and ≥1 mm, dorsal angulation >5°.
III	Displaced with slight dorsal comminution, length of radial styloid ≤4, dorsal angulation >5°.
IV	Comminution of distal radius (including the dorsal part), often with intraarticular involvement. Length of radial styloid usually negative, dorsal angulation >5°.

Frykman classification concentrated on articular and ulnar (styloid or shaft) involvement. He specifically differentiated involvement of radiocarpal and distal radioulnar joint, as intra-articular involvement and ulnar involvement were the most prognostic factors.

	Ulnar styloid fracture	Ulna styloid fracture
	ABSENT	**PRESENT**
EXTRA ARTICULAR	I	II
INTRA ARTICULAR		
RADIO CARPAL JOINT	III	IV
RADIO ULNAR JOINT	V	VI
RADIO CARPAL& RADIO ULNAR JOINT	VII	VIII



Melone classified intra-articular fractures considering that each fracture consisted of four parts:

i) radial styloid,

ii) dorsal medial fragment,

iii) volar medial fragment, and

iv) the radial shaft.

The medial complex is the two medial fragments, which make up the lunate fossa and based his classification on the medial complex position.

Type 1—The medial complex is not displaced or minimally displaced as a unit without any comminution. Closed reduction yields stable result.

Type 2—The medial complex is moderately or severely displaced as a unit with cortical comminution on volar and dorsal aspect. "Die punch" and unstable

A—Irreducible, closed.

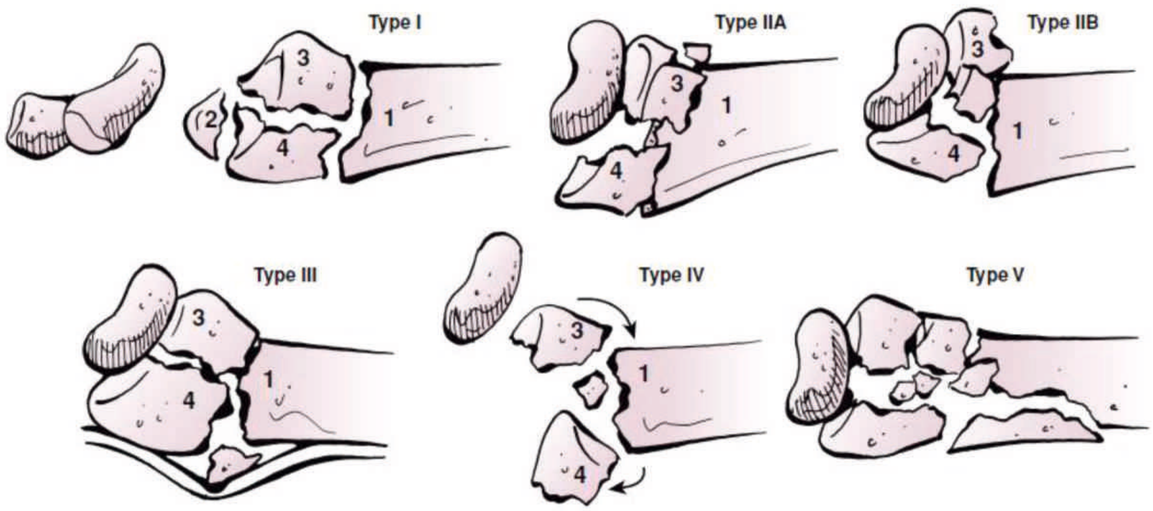
B—Irreducible, closed because of impaction.

Type 3—As type 2 but with a spike of the radius on volar side, which may compromise the median nerve.

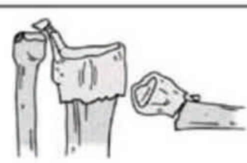
Type 4—Split fracture and unstable. The medial complex fragments are severely comminuted with rotation of fragments.

Type 5—Explosion injury. Severe displacement and comminution often associated with diaphyseal comminution.

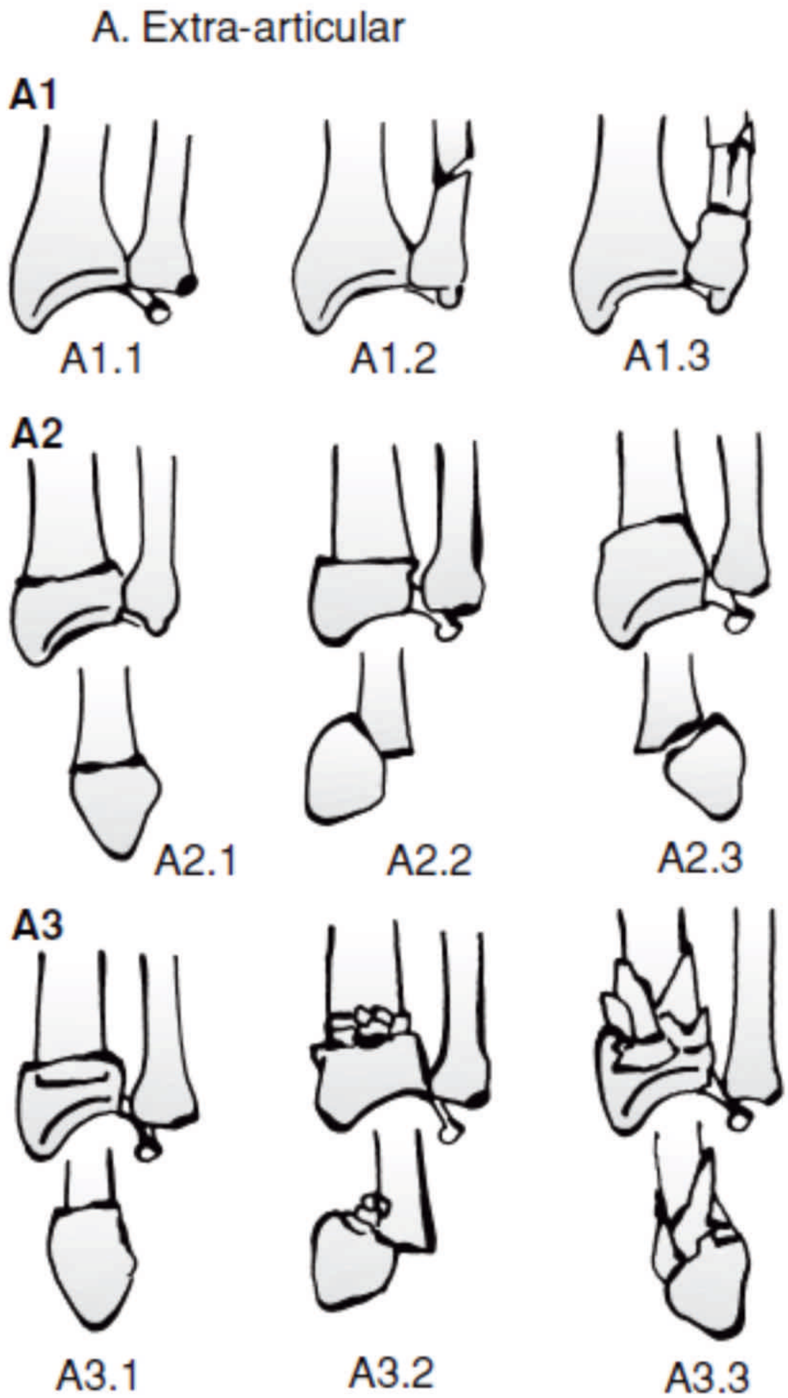
Melone's classification



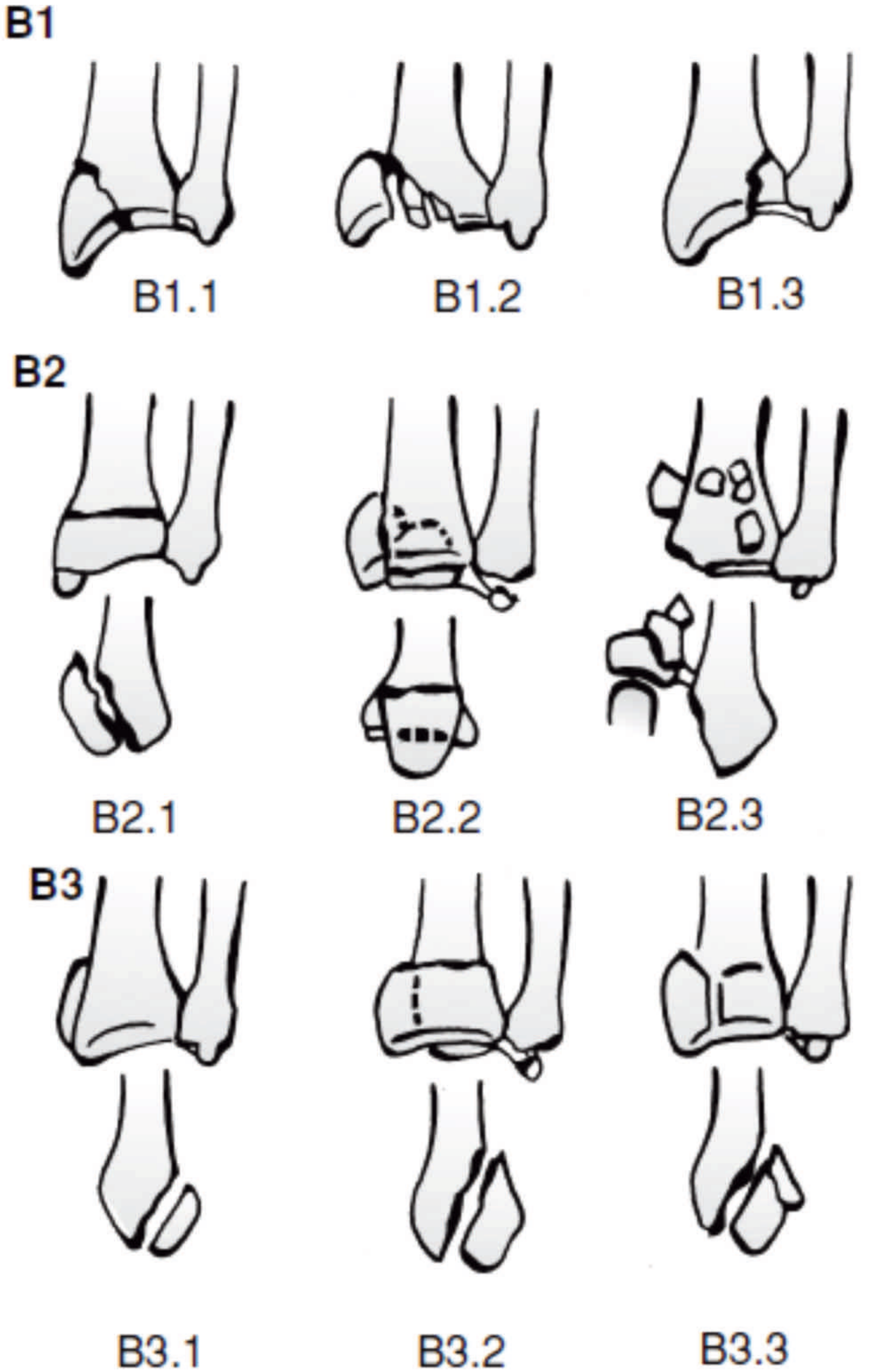
FERNANDEZ (1987)

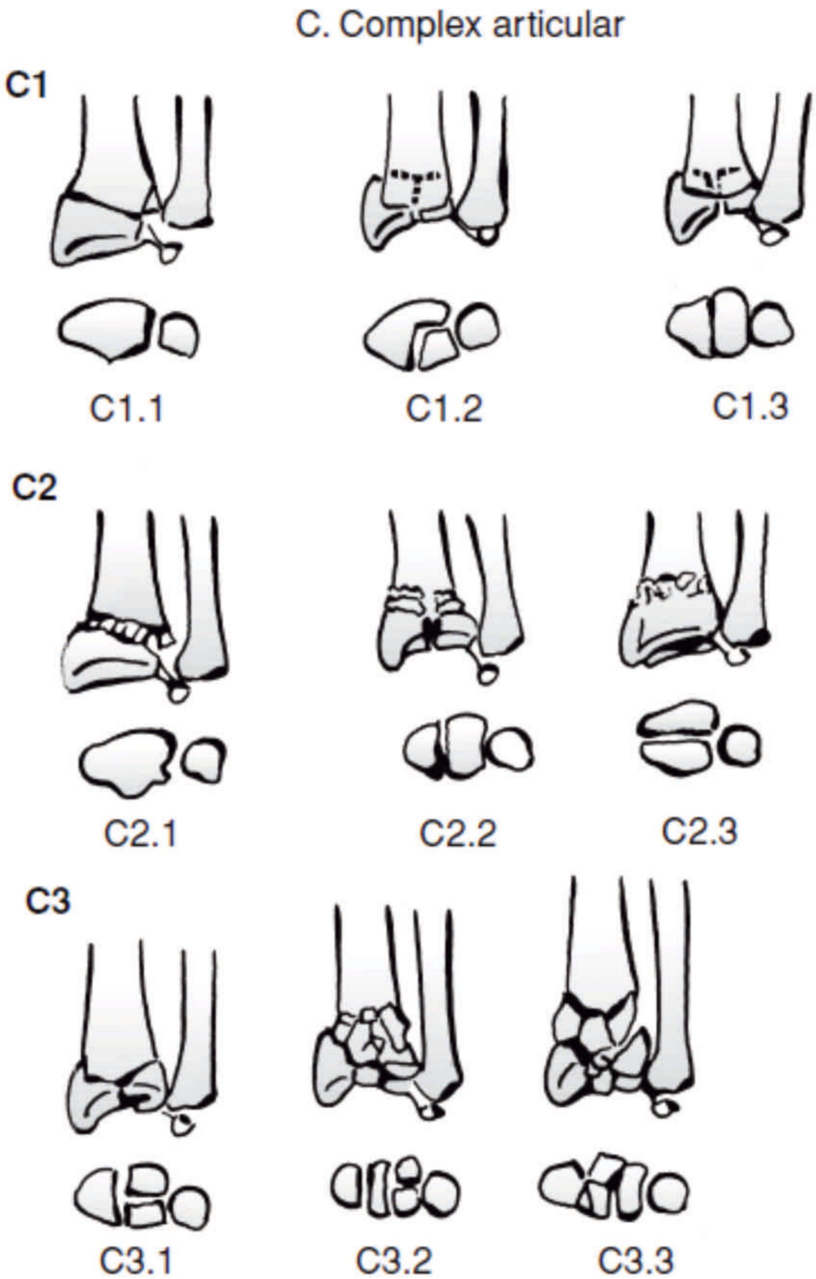
Fracture Types (Adults) Based on the Mechanism of Injury		Children Fracture Equivalent	Stability/ Instability: High Risk of Secondary Displacement After Initial Adequate Reduction	Displacement Pattern
Type I Bending fracture of the metaphysis		Distal forearm Fracture Salter II	Stable Unstable	Non-displaced Dorsally (Col-les-Pouteau) Volarly (Smith) Proximal Combined
Type II Shearing fracture of the joint surface		Salter IV	Unstable	Dorsal Radial Volar Proximal Combined
Type III Compression fracture of the joint surface		Salter III, IV, V	Stable Unstable	Non-displaced Dorsal Radial Volar Proximal Combined
Type IV Avulsion fractures, radio carpal fracture dislocation		Very rare	Unstable	Dorsal Radial Volar Proximal Combined
Type V		Combined fractures (I-II-III-IV) high-veloc-ity injury	Very rare	Unstable

AO/OTA classification is an inclusive, alphanumeric classification and has 27 different subgroups. Three different types (A—extra-articular, B—partial articular, and C—complete articular) are divided into 9 main groups and 27 different subtypes depending on comminution and direction of displacement.



B. Simple articular





RELIABILITY OF CLASSIFICATION SYSTEMS

A number of studies have investigated the reliability of the classification systems for distal radius fractures. At best, inter- or intraobserver reliability has been demonstrated for AO/OTA system when only types A, B, or C are considered.

Other studies considering both the AO/OTA classification and other classifications fail to demonstrate reliability except for Older classification in which Anderson et al. showed high inter and intraobserver reproducibility. Solgaard demonstrated the prognostic value of this system. However, undue reliance should not be placed on the classification systems especially in considering treatment and prognosis.

MECHANISM OF INJURY

The common injury mechanism that results in fracture of the distal radius is fall on to the outstretched hand from standing height, although a small proportion of patients will experience high-energy injury. Palvanen et al. demonstrated that the typical osteoporotic upper extremity fractures in older adults have specific injury mechanisms with individuals with distal radius fractures significantly more frequently breaking their fall with an outstretched hand compared to those sustaining proximal humerus or elbow fractures. This suggests that patients with distal radius fractures have better preserved reflexes and are generally fitter than those with proximal humerus fractures.

The different characteristics of fractures of distal radius are generally agreed to be influenced by position of hand at the time of impact, the type of surface with which the hand makes contact, and velocity of the force. Added to this the quality and strength of bone of the distal radius will influence the severity of the fracture.

Most attention has been focused on position of the hand at the time of impact. In the late 19th century, Lilienfeldt demonstrated using cadaver arms that both the position of the hand and the angle at which forearm strikes the ground determine the type of fracture. Fracture of distal radius resulted if the angle was between 60 and 90 degrees with radial styloid fracture resulting from hand in ulnar deviation and an ulnar styloid fracture from radial deviation. Lilienfeldt also reproduced volar displaced fracture with the hand in flexion. Frykman refined these experiments and concluded that clinical types of the distal radius fractures occurred, provided dorsiflexion of wrist was between 40 and 90 degrees. If degree decreases, a proximal forearm fracture resulted and if more angulated, a carpal bone fracture. More force was required to produce a fracture with increasing the dorsiflexion. He produced volar fractures when hand was loaded in volar flexion. Frykman also noted that more force was required to fracture a male specimen compared to a female specimen.

Fernandez and Jupiter divided the distal radius fractures into five types depending on the mechanism of injury and this forms the basis for Fernandez classification. They believe that the bending fractures occur because at impact the proximal carpal row transmits force to the dorsal aspect of radius and the volar cortex fails because of the tensile stresses. The dorsal cortex compresses producing dorsal comminution and metaphyseal defect especially in an osteopenic patient, if the radius bends dorsally. With the forearm supinated and the elbow extended, the force is applied with the wrist in flexion and the displacement is reversed producing compression of volar lip and an extra-articular volar displaced bending fracture. Partial articular or shearing fractures of the volar lip of distal radius probably occur in the same way as extra-articular volar displaced fractures in younger patients. In these cases the compression of the volar lip results in an articular fracture with volar subluxation of the carpus. The fracture line is often vertical and usually unstable. The severity of distal radius fractures is related to the quality of bone.

Clayton et al. study showed that there was a linear correlation between early instability and malunion and dual energy x-ray absorptiometry T scores. Patients with osteoporosis had 43% probability of having metaphyseal unstable distal radius fracture and 66% probability of malunion compared with patients with normal T-scores who had 28% probability of instability and 48% probability of malunion. Xie and Barenholdt used multilayer peripheral quantitative CT scans to show that cross-sectional volumetric density and geometric properties of the cortical bone may be essential in determining severity of distal radius fracture.

ASSOCIATED INJURIES

The main injuries associated with distal radius fractures are injuries to the interosseous ligaments of the carpus and triangular fibrocartilage complex (TFCC). Chondral lesions have been reported in 32% of patients. Their significance is that they may be precursors of degenerative change.

Interosseous Ligament Injury:

Interosseous ligament injury associated with fractures of distal radius is predominantly scapholunate and lunatotriquetral injury. The severity of these injuries has been graded by Geissler from grade 1 to grade 4 using arthroscopy.

- Grade 1 injuries are the least severe with attenuation or hemorrhage,
- grades 2 and 3 are increasing incongruity of the ligament, and
- grade 4 is gross instability with sufficient disruption to allow passage of an arthroscope from radiocarpal to midcarpal joints.

Scapholunate injury has been reported to occur in between 4.7% and 46% of the distal radius fractures.

Triangular Fibrocartilage Complex(TFCC) Injury

TFCC injury is commoner than interosseous ligament injury. The majority are peripheral avulsions and associated with ulnar styloid fractures, the presence of which increases risk of a TFCC tear by a factor of 5.1. In a long-term review at 13 to 15 years after injury there were no differences in the Disabilities of Arm, Shoulder and Hand (DASH) score between patients with and without complete TFCC tears or between those with or without detectable laxity at the distal radio-ulnar joint (DRUJ) barring a reduction of grip strength to 83% in patients with laxity. It is debatable if this is clinically significant. **Surgery to repair the TFCC tears has good reported results although similar to the non-operatively managed patients with average grip strength of 78% and DASH score of 13 at 2 years after surgery.**

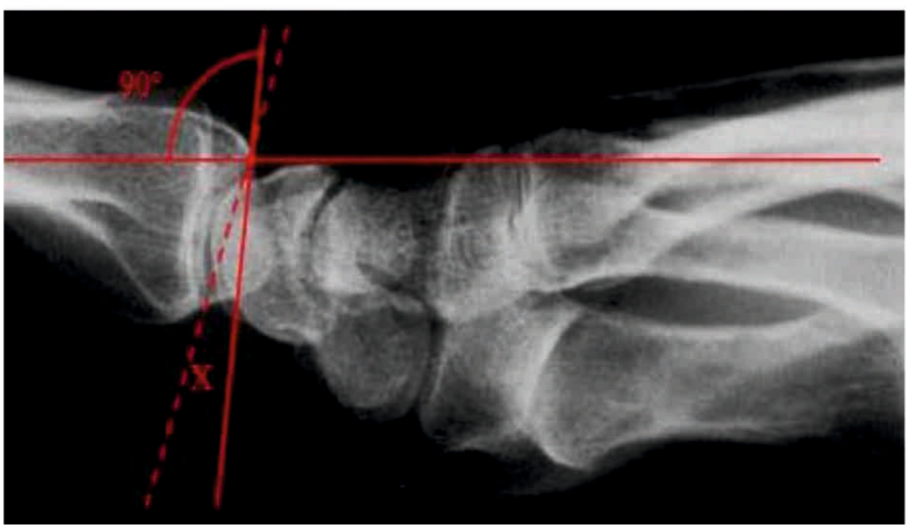
INVESTIGATIONS

In case of suspicion of distal radius fracture the standard radiological views include i) anteroposterior view, ii) lateral view and iii) oblique view. For assessment of associated injuries and fracture displacements additional views may be needed.

A number of radiologic measurements quantifying the orientation of the distal radius are in common use and it is important to understand these to reduce interobserver error.

Dorsal/palmar tilt: The angle sustained by the line drawn between the distal most ends of the dorsal and volar lips of radius with the line drawn parallel to the longitudinal axis of the radius on the lateral view defines the palmar/dorsal tilt.

NORMAL VOLAR TILT: 11 DEGREES



Radial length: In the PA view the radial length is measured as the distance between these two lines :

I) A perpendicular line drawn at the distal most end of ulnar head

ii) A line drawn at the distal most end of styloid process of radius and perpendicular to its longitudinal axis.

Usually measured in millimetres

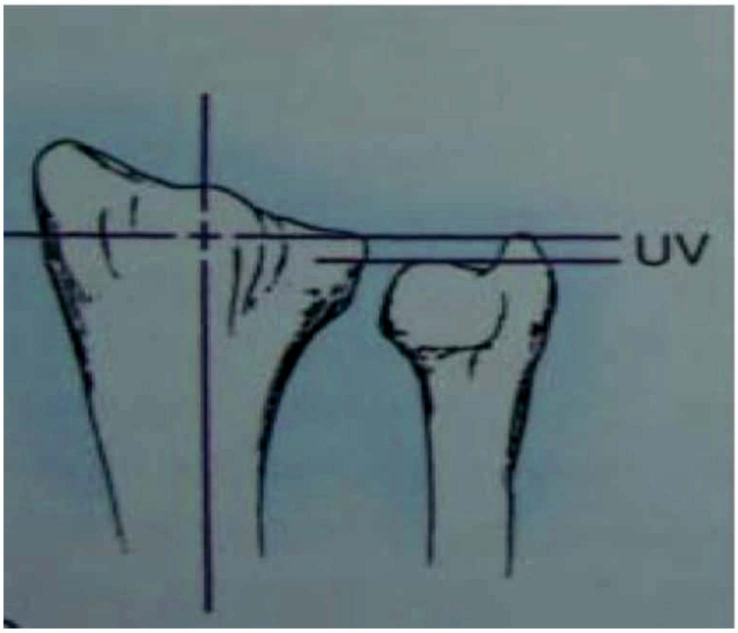
NORMAL VALUE 12 MM

Ulnar variance: It indicates the quantity of shortening of radius and not to be confused with radial length parameter. It is the vertical distance between these two parallel lines:

i) line perpendicular to the longitudinal radial axis and parallel to the articular surface on the medial end of the distal radius.

ii) Similar perpendicular line passing through the distal most aspect of the ulnar head articular surface.

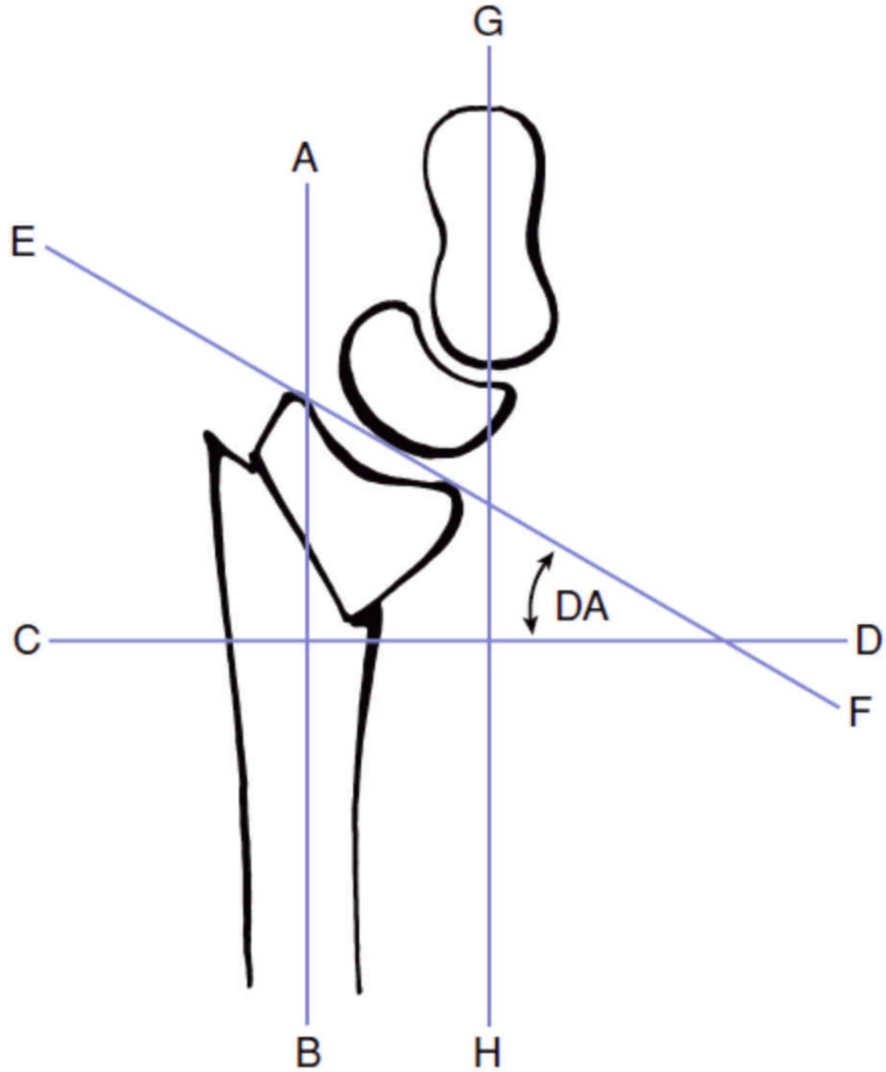
NORMAL VALUE : 0 TO -2MM



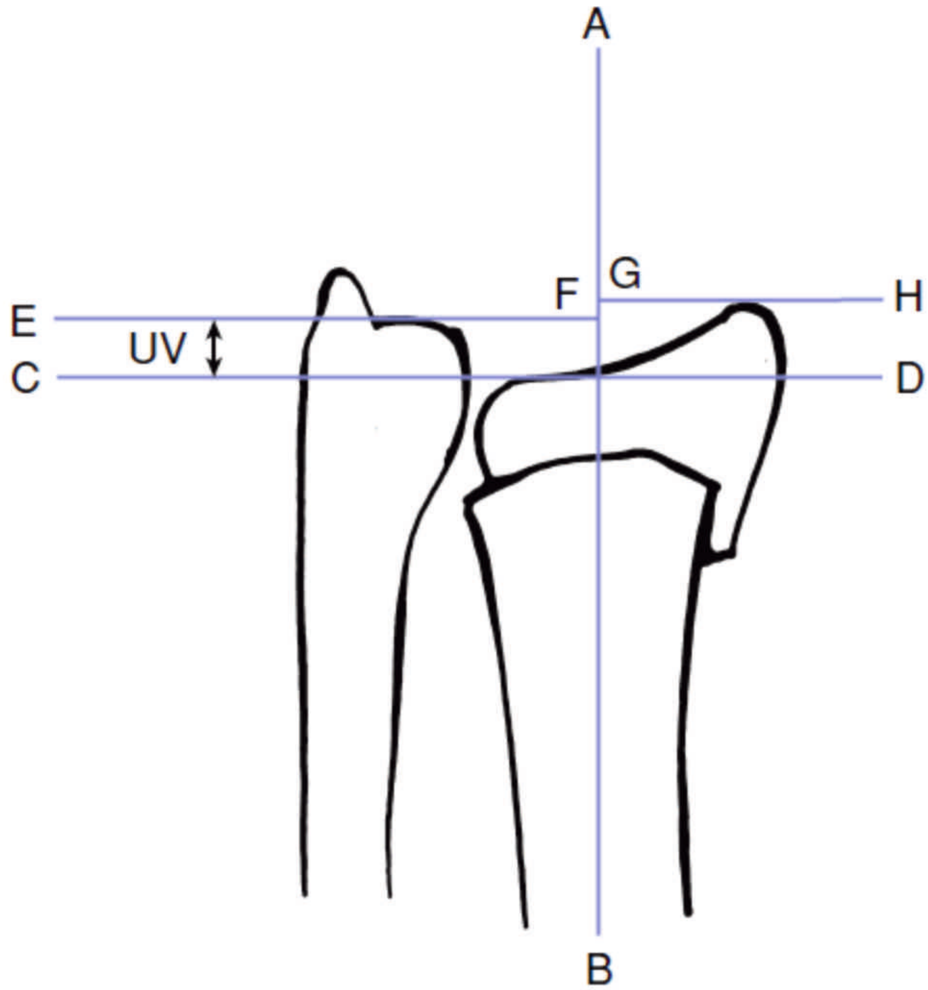
Radial inclination: The angle sustained by the line drawn along the distal articular surface of the radius with the line perpendicular to the longitudinal axis of the radius is defined as the radial inclination which indicates the amount of inclination of radius towards the ulna. It is best appreciated in Posteroanterior x-ray.

RADIAL INCLINATION NORMAL VALUE - 23 DEGREES

Carpal malalignment: There are two types of carpal malalignment associated with fracture of the distal radius. The commonest is malalignment which compensates for the tilt of the distal radius and is extrinsic to the carpus. On a lateral view one line is drawn along the long axis of the capitate and one down the long axis of the radius. If the carpus is aligned the lines will intersect within the carpus. If not they will intersect out with the carpus. Carpal malalignment can also be caused by associated carpal ligament disruption.



The dorsal angle (DA) is measured by finding the angle between a line (CD) perpendicular to the long axis of the radius (AB) and a line joining the dorsal and volar extremities of the radiocarpal joint (EF). Carpal alignment is assessed by the point of intersection of the line parallel to the long axis of the radius (AB) and a line parallel to the long axis of the capitate (GH). If these intersect outwith the carpus or do not intersect as in this illustration, then the carpus is malaligned.



Ulnar variance (UV) is the distance between two lines perpendicular to the long axis of the radius (AB). The first is tangential to the ulnar corner of the radius (CD) and the second tangential to the ulnar head (EF). Radial length is the distance between line EF and a line tangential to the radial styloid (GH).

Teardrop angle and anteroposterior (AP) distance: More recently, attention has been drawn to examination of the teardrop angle and AP distance, as measured on a lateral radiograph. The teardrop of the distal radius articular surface refers to the U-shaped outline of the volar rim of the lunate facet. The teardrop angle refers to the angle between the central axis of the teardrop and the central axis of the radial shaft. Depression of the teardrop angle to less than 45 degrees indicates displacement of the lunate facet. A depressed teardrop angle may be the only evidence that reduction is incomplete and articular incongruity remains. The AP distance is also a measure of articular incongruity and is defined by the distance between the apices of the dorsal and volar rims of the lunate facet. The normal AP distance averages 19 mm on a true lateral view, but is probably best assessed by comparison with the contralateral normal wrist.

A lateral view of a displaced intra-articular distal radius fracture showing a depressed teardrop angle of just over 10 degrees.

Specific features should be assessed on each view of the distal radius as follows.

PA View

For extra-articular fractures assess the following:

- Radial length/ulnar variance
- Extent of metaphyseal comminution
- Ulnar styloid fracture location (tip/waist/base)

In addition, for intra-articular fractures assess the following:

- Presence and orientation of articular fractures
- Depression of the lunate facet
- Gap between scaphoid and lunate facet
- Central impaction fragments
- Carpal bone assessment—Gilula's carpal arc 1 or evidence of a scaphoid fracture

Lateral View

For extra-articular fractures assess the following:

- Dorsal/palmar tilt
- Extent of metaphyseal comminution
- Carpal alignment
- Displacement of the volar cortex
- Position of the DRUJ

For intra-articular fractures assess the following:

- Depression of the palmar lunate facet
- Depression of the central fragment
- Gap between palmar and dorsal fragments
- Scapholunate angle for possible associated carpal injury
- Teardrop angle
- AP distance

Measurement of dorsal and volar tilt should be made on a true lateral view of the distal radius when the ulna is completely superimposed on the radius. Pronation of the forearm reduces the apparent volar tilt and supination increases it although it does not affect the measurement of radiolunate or carpal alignment. Johnson and Szabo found that a 5-degree rotational change produces a 1.6-degree change in palmar tilt on the conventional lateral view and a 1-degree change on the 15-degree lateral view.

Oblique Views. The pronated oblique view demonstrates the radial side of the distal radius and is particularly useful for assessing radial comminution, a split or depression of the radial styloid, and for confirming the position of screws on the radial side of the distal radius. The supinated oblique view demonstrates the ulnar side of the distal radius and is useful for assessing depression of the dorsal lunate facet and the position of ulnar-sided screws.

Tilted Lateral View. This is a lateral view taken with a pad under the hand to incline the radius 22 degrees toward the beam. It provides a tangential view of the lunate facet and allows more accurate measurement of lunate facet depression and possible screw penetration into the radiocarpal joint.

Traction Views (AP and Lateral). These views are taken with manual traction or finger traps applied after reduction and under anesthetic. They are most useful in articular fractures and allow the surgeon to plan whether closed techniques will be sufficient for treatment or whether open reduction will be necessary. A traction view also helps to identify fracture fragments that may be obscured by the displacement of the fracture and emphasizes any disruption of Gilula's arc in the proximal carpal row in associated interosseous ligament injury.

Contralateral Wrist (AP and Lateral). These x-rays may be indicated prior to surgery to assess the patient's normal ulnar variance, scapholunate angle, and AP distance, all of which vary between patients.

Computerized Tomography

Computerized tomography (CT) scanning is used to improve the visualization and accuracy of measurement of articular fractures in the distal radius. Clinical data suggest that CT demonstrates intra-articular fracture lines and measures intra-articular displacement more accurately than plain radiographs, and in particular demonstrates the presence and displacement of sigmoid notch fractures more accurately than plain radiographs.

Three-dimensional CT scans are now commonly used in assessing intra-articular fractures of the distal radius. Their use has been shown to improve intraobserver but not interobserver agreement and to allow a reliable determination of fracture characteristics which may influence treatment such as coronal fracture lines, central articular depression, and articular comminution. The use of this technique has been shown to increase the perceived need for open exposure of displaced articular segments when compared to conventional CT, but the influence of this on functional outcome has yet to be determined.

PRINCIPLES OF MANAGEMENT

ASSESSMENT OF STABILITY

LaFontaine et al. described these factors predictive of instability:

(1) initial dorsal angulation > 20 degrees (volar tilt),

(2) metaphyseal comminution on dorsal aspect,

(3) involvement of articular surface,

(4) associated fracture of ulna,

(5) age > 60 years.

The original AO principles were:

- Anatomic fracture reduction & fixation (as we know not always possible).
- Rigid fracture stability (not always possible).
- Preservation of blood supply through careful soft tissue approaches and fracture reduction techniques (sometimes the blood supply is damaged from the injury).
- Early return to function of the plated limb.

With the understanding that not all fractures can be reconstructed, the "rules" have been somewhat modified to:

- Long bones must have axial re-alignment but not necessarily anatomic perfection. Anatomic reduction is still necessary for joints.

- Appropriate construct stability to ensure fracture healing via direct or indirect healing.
- **Atraumatic approaches and fracture reduction or minimally invasive approaches.**
- Early return to mobility.

Fractures can and will heal under both conditions but that is if the appropriate condition is chosen for the appropriate fracture situation!

Developing a treatment plan is very essential which is dependent on numerous factors such as quality of bone, demand and age of the patient, the characteristics of injury and reduction.

So the objectives of treatment of distal radius fractures are

1. To restore the articular congruity
2. To achieve proper alignment
3. To regain functional range of wrist joint movements
4. To treat the associated injuries

METHODS OF TREATMENT

There are various methods for treating an adult with distal radius fracture

a) Conservative management

b) Surgical treatment

i. Percutaneous pinning
ii. Spanning external fixation
iii. Non- spanning external fixation
iv. Open reduction and dorsal plating
v. Open reduction and volar plating
vi. Open reduction and fixation with locking compression plate
vii. MIPO
viii. Open reduction and fragment specific fixation for comminuted fracture
ix. Distraction plating

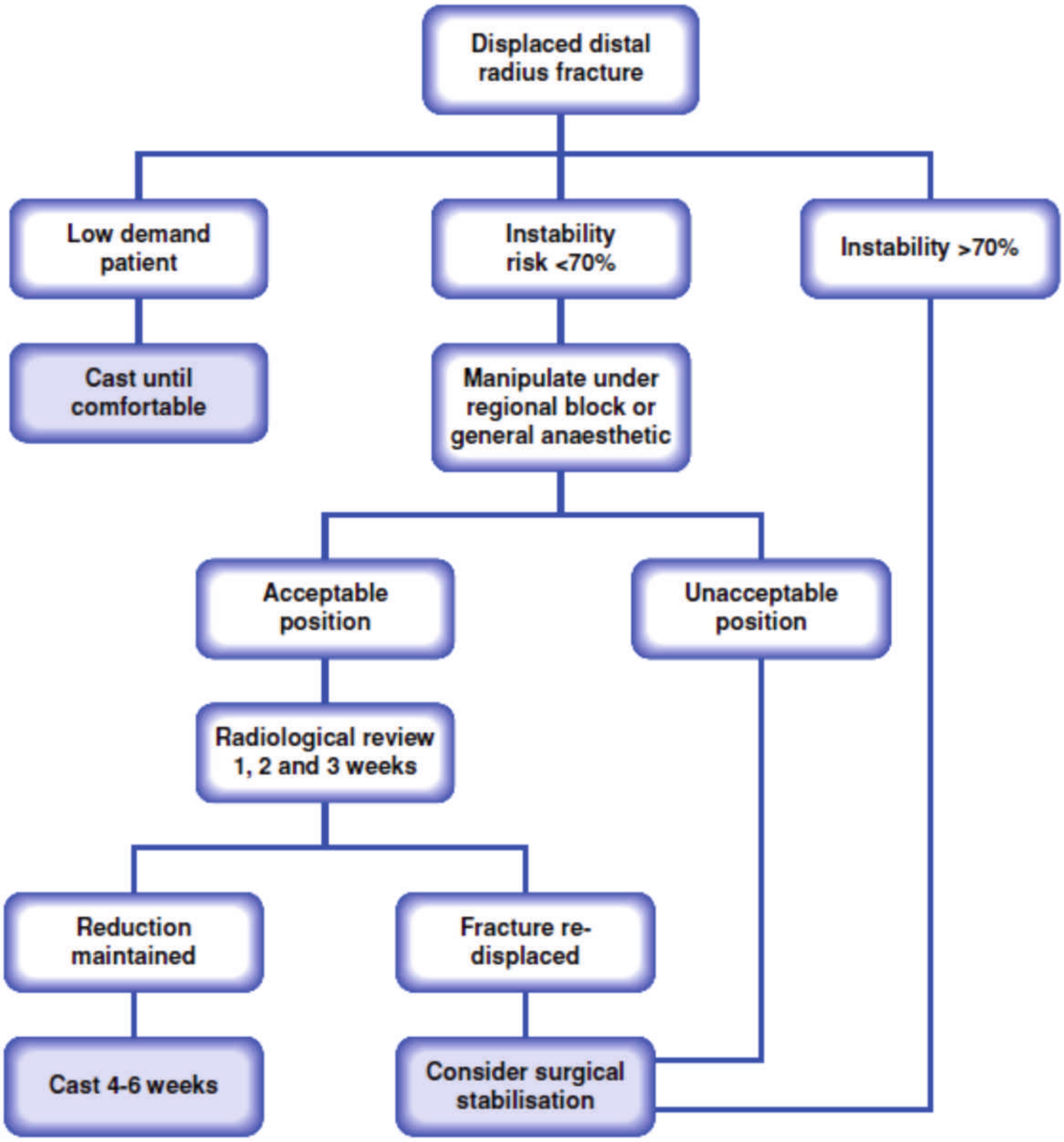
CONSERVATIVE MANAGEMENT

Undisplaced or minimally displaced fractures (without carpal malalignment, less than 10 degrees of dorsal tilt and less than 3 mm of ulnar variance) are treated without manipulative reduction in either a forearm cast or removable splint with radiologic review at 1 week. If the fracture is undisplaced, the risk of metaphyseal instability is less than 70%, the patient is reviewed at 3 weeks and if x-rays are satisfactory the wrist is mobilized.

Displaced fractures are carefully assessed for risk of instability and articular malalignment. If there is articular displacement of more than 2 mm gap or step or if the risk of metaphyseal instability is greater than 70%, early operative reduction and stabilization is recommended. If there is acceptable articular alignment and the risk of instability is less than 70%, manual manipulative reduction is performed under regional anaesthesia. Agee's technique is used if necessary to restore volar tilt. The wrist is immobilized in the neutral position in a forearm back slab if an acceptable reduction is obtained. If the reduction maneuvers fail then surgery is planned. Reduced fractures are reviewed at 1, 2, and 3 weeks with the slab being completed or replaced with a full forearm cast at 1 week. Cast immobilization is maintained for 4 to 6 weeks depending on the evidence of radiologic healing and the symptoms.

Radiographic Criteria for Acceptable Reduction of Distal Radial Fracture

CRITERION	NORMAL	ACCEPTABLE
Ulnar variance (radial length)	±2 mm comparing level of lunate facet to ulnar head	No more than 2 mm of shortening relative to ulnar head
Radial height	12 mm	????
Palmar (lateral) tilt	11 degrees of volar tilt	Neutral
Radial inclination	20 degrees as measured from lunate facet to radial styloid	No less than 10 degrees
Intraarticular step or gap	None	Less than 2 mm of either



SURGICAL MANAGEMENT

Indication for surgery

- Metaphyseal unstable extra- or minimal articular fractures,
- Displaced articular fractures, and
- Partial articular fractures.

External fixation:

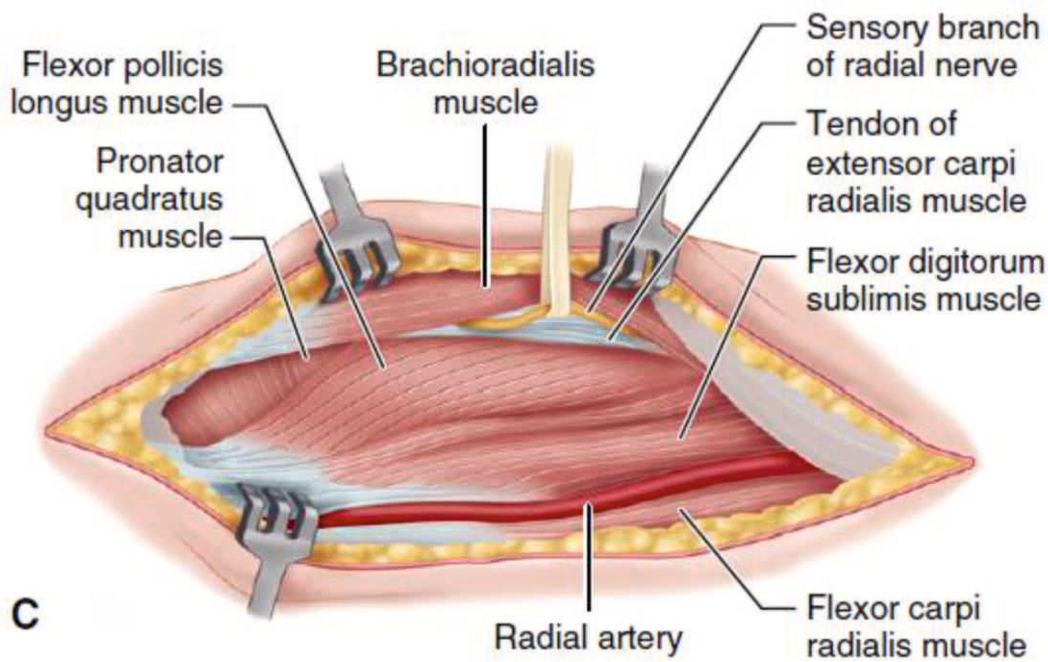
Under general anaesthesia or brachial block reduce the fracture manually. Through a small skin incision over the dorso-radial aspect of index metacarpal base, expose the metacarpal. At a 30-45 degree of inclination, a 3 mm self-tapping half-pins is inserted on the dorsal aspect of hand and forearm. The position of the pins and length is confirmed with image intensifier.

Through a small skin incision made 8 to 10 cm proximal to the wrist joint, expose the superficial branches of the lateral antebrachial cutaneous and radial sensory nerve. Two 3-mm half pins are inserted with a distance of 1.5cm separation, through a soft tissue protector with inclination of 30 degrees to the dorsal aspect of radius between the radial wrist extensors. The pins should just perforate the medial cortex of radius. Apply the external fixation frame confirming reduction of the fracture which can be further augmented with k-wires.

Augmented external fixation has comparable results with plating. Further external fixation has prime role in compound and severely comminuted fractures, at least for initial management.

ORIF with plating:

Approach: With the forearm in supination, make a longitudinal incision over the interval between the brachioradialis and the flexor carpi radialis muscles. Identify and protect the sensory branch of radial nerve, which lies beneath brachioradialis muscle. Carefully mobilize and retract medially the flexor carpi radialis and the radial artery and vein. The flexor digitorum sublimis, FPL, and pronator quadratus muscles are exposed. Beginning at the anterolateral edge of radius, elevate subperiosteally the flexor pollicis longus and the pronator quadratus and strip them medially.



The fracture line is now clearly visualised and reduced by manipulation and ligamentotaxis. Provisional k-wires may be used to maintain reduction. The appropriate plate with 3.5mm cortical and 4mm cancellous screws is applied. It is safer to check the screw size in fluoroscope to prevent later complications. Pronator quadratus sutured covering the distal end of plate to prevent tendon irritation. The plate functions in two ways – buttress the distal fragment and maintains metaphyseal reduction.

COMPLICATIONS:

Complications After Fracture of Distal Radius

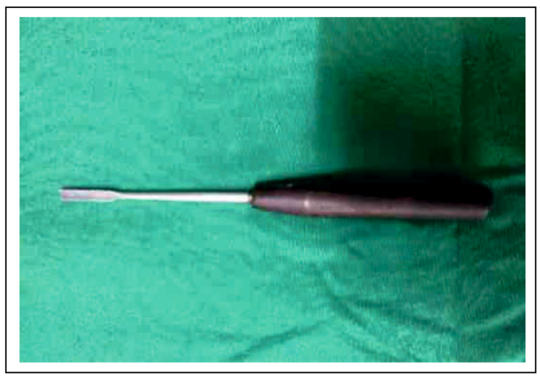
COMPLICATION	INCIDENCE (%)	NO. OF STUDIES*
Arthritis/arthrosis	7%-65%	4
Loss of motion	0%-31%	10
Hardware complications	1.4%-26%	14
Nerve compression/neuritis	0%-17%	11
Osteomyelitis	4%-9%	2
Dupuytren contracture	2%-9%	4
Persistent pain/pain syndromes (CRPS)	0.3%-8%	11
Tendon (rupture, lag, trigger, tenosynovitis)	0%-5%	3
Delayed union/nonunion	0.7%-4%	4
Radioulnar (synostosis, disturbance)	0%-1.3%	2

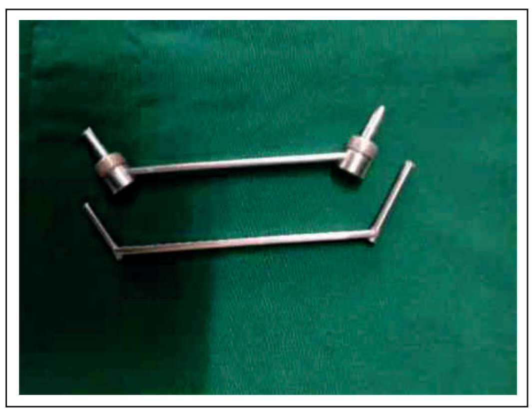
Malunion with intra or extra articular deformity is the most common complication and is common in non-operative treatment. The common deformity is “shortening, loss of volar tilt and ulnar inclination, and distal fragment rotation”.

IMPLANT PROFILE

Small fragment instruments:

- Drill bit- 2.5 mm diameter : used to prepare the thread hole for the 3.5mm cortical and 4.5mm cancellous screw.
- Depth gauge, 3.5mm : for small fragment screws upto 60mm.
- Tap for 3.5mm cortical screw.
- Double drill sleeve, 3.5mm and 2.5mm
- Small hexagonal screw driver





- Retractor for small fragments, width 8mm, 160mm
- Skin hooks, single and double pronged
- Periosteal elevator, round edge, width 6mm : used to develop a plane below the pronator quadratus for sliding the plate without widely stripping the periosteum.
- 3.5mm cortical screw system
- 4mm cancellous screw system (fully and partially threaded)
- Small T plate, right-angled : slightly concave and the head portion is bent to accommodate the volar surface of distal radius. One hole is elongated to allow preliminary adjustment of plate. Shaft is fixed with 3.5mm cortical screws and head part with 4.0mm cancellous screws.
    - Thickness – 1.2mm
    - Width – 10mm

There is a lot of scoring system for evaluation of outcome. We followed the scoring system of Mayo wrist score for evaluation. Other systems used in distal radius fracture outcome study includes DASH, Green and O'Brien score, Gartland and Werley score and Patient-Related Wrist Evaluation (PRWE) Score.

Mayo Wrist Score

Patient's name (or ref) ________________

Please answer the following 12 multiple choice questions.

During the past 4 weeks......

Section 1 - Pain Intensity

- No pain
- Mild Occasional
- Moderate, tolerable
- Severe to intolerable

Section 2 - Functional Status

- Returned to regular employment
- Restricted employment
- Able to work, but unemployed
- Unable to work because of pain

Section 3 (choose either 3a or 3b)

3a - Range of Motion (% of normal side)

- 100%
- 75-99%
- 50-74%
- 25-49%
- 0-24%

3b - If only injured hand examined

- Greater than 120 degrees
- 90-120 degrees
- 60-90 degrees
- 30-60 degrees
- less than 30 degrees

Section 4 - Grip strength % of normal

- 100%
- 75-100%
- 50-75%
- 25-50%
- 0-25%

The Mayo Wrist Score is 0

Interpreting the Wrist Mayo Score

90-100 Excellent 80-90 Good 60-80 Satisfactory Below 60 Poor

PART – B

PREAMBLE

Distal radius fractures are one of the most commonly occurring fracture in people of various ages. Various treatment modalities are available for managing distal radius fractures with each having its own merits and demerits. Open reduction often results in extensive soft tissue injury, scarring and stiffness. The technique of MIPO is recently utilised in various centres for minimising this complication.

This series include 23 cases of distal radius fractures, all are fixed with minimally invasive plate osteosynthesis. The outcome was analysed by the range of movements, pain and disability. Based on our finding we hereby submit "Prospective study of functional outcome of distal radius fracture managed by minimally invasive plate osteosynthesis".

AIM OF THE STUDY

To evaluate **functional outcome of distal radius fractures treated by minimally invasive plate osteosynthesis**, in the Department of Orthopaedics, Tirunelveli Medical College Hospital, over a period of two years from August 2013 to August 2015.

MATERIALS AND METHODS

This is a prospective study of 23 cases of distal radius fractures ttreated with minimally invasive plate osteosynthesis.

The period of study and follow up extends from August 2013 to August 2015.

MATERIALS

Twenty three patients were randomly selected from the admissions in the accident and emergency ward in Department of Orthopaedics in Tirunelveli Medical College Hospital, Tirunelveli and recruited into the study prospectively based on the following criterias.

INCLUSION CRITERIA:

1. Age above 20 years
2. Closed distal radius fractures
3. Extra articular and minimally comminuted intra articular fractures.

EXCLUSION CRITERIA:

1. Age less than 20 years
2. Compound fractures
3. Severely comminuted intra articular fractures
4. Severe osteoporosis

ANALYSIS OF FUNCTIONAL OUTCOME

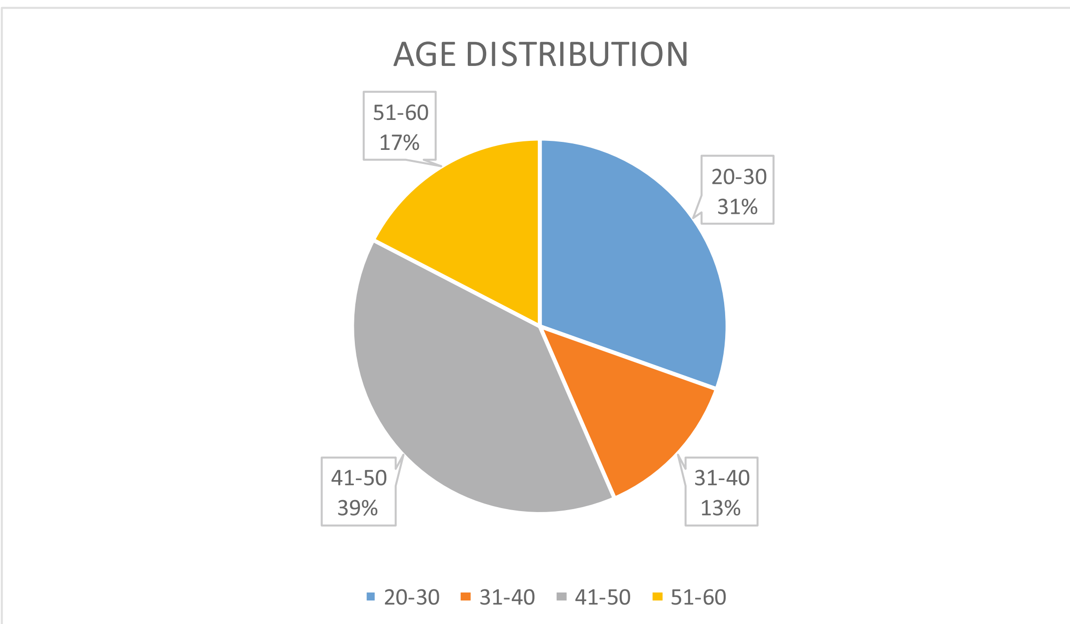
All the cases were analysed as per the following criteria

1. Age distribution
2. Sex distribution
3. Side of injury
4. Mode of injury
5. Classification of fractures
6. Time interval between injury and surgery
7. Associated injuries
8. Complications
9. Mayo wrist score

I. AGE DISTRIBUTION

The age group varied from 20 to 70 years with mean age of 41 years. Incidence of fracture was observed maximum between 40 to 50 years of age.

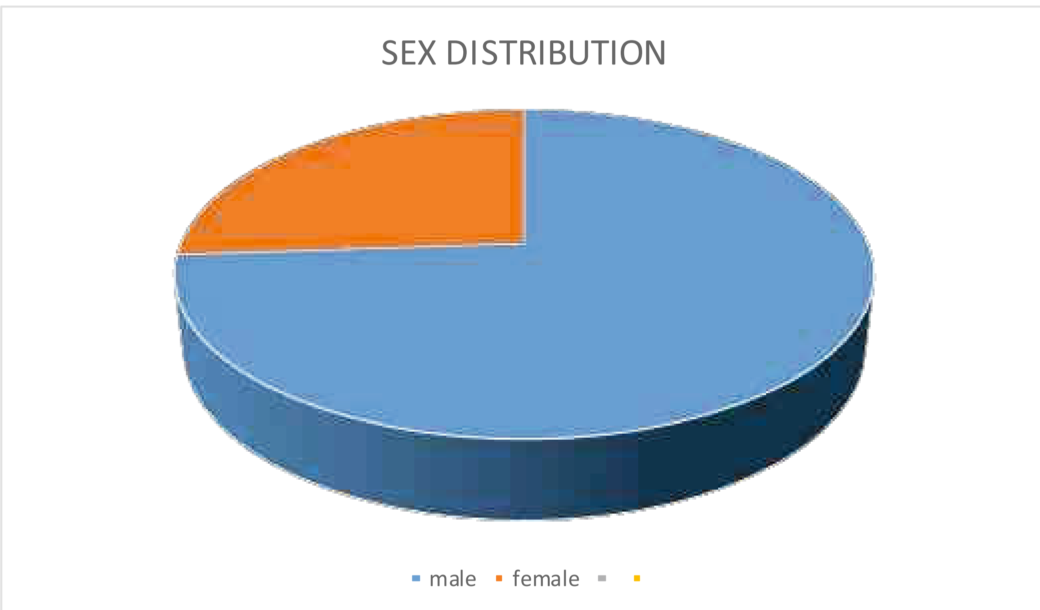
Age Group	Number Of Cases	Percentage
20-30	7	31%
31-40	3	13%
41-50	9	39%
51-60	4	17%



II. SEX DISTRIBUTION

Males are affected more in our study compared to females.

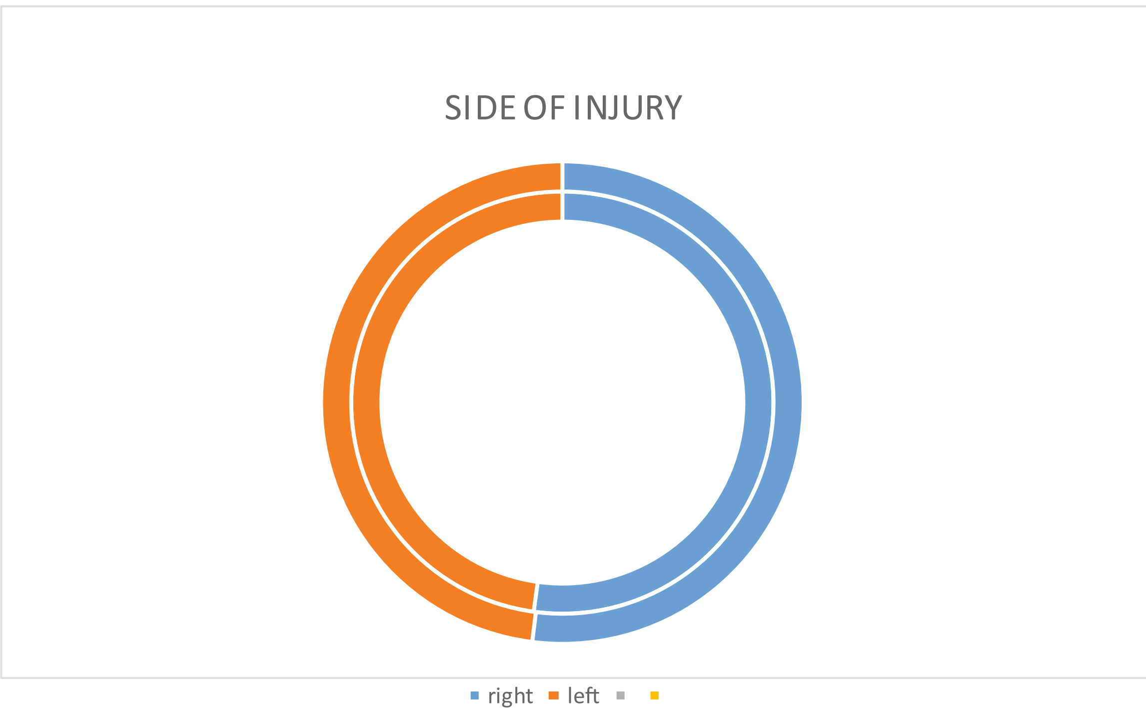
Sex	Number Of Cases	Percentage
Male	17	78
Female	6	22



III. SIDE OF INJURY

Right side was common in our study.

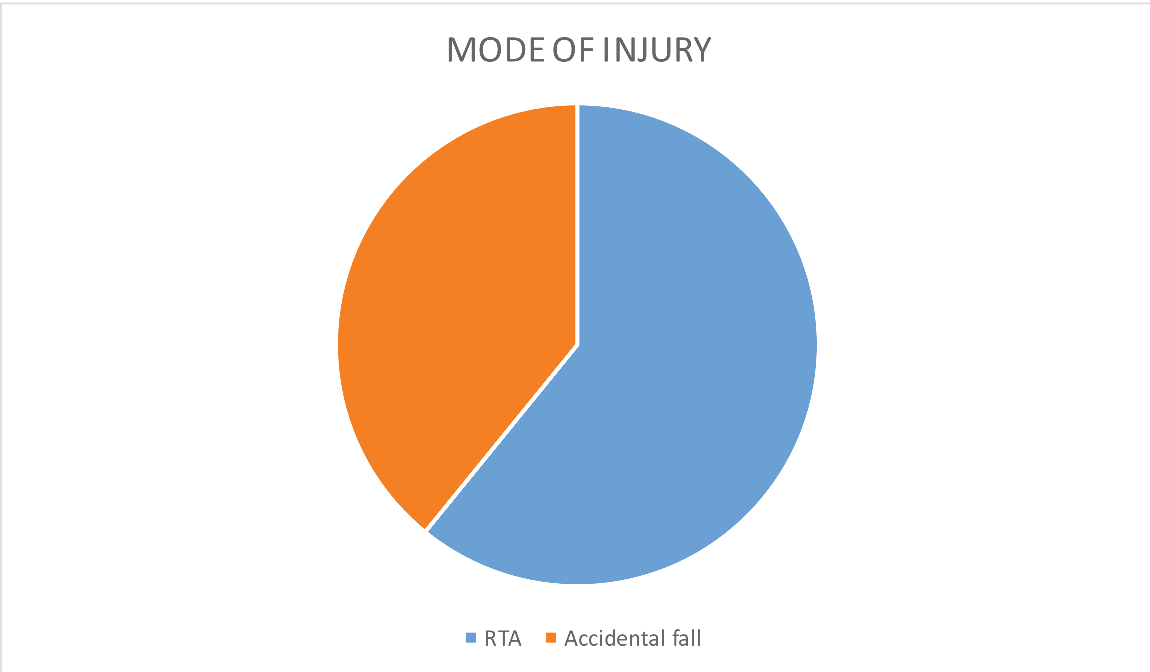
SIDE	NO. OF CASES	PERCENTAGE
Right	12	52%
Left	11	48%



IV. MODE OF INJURY

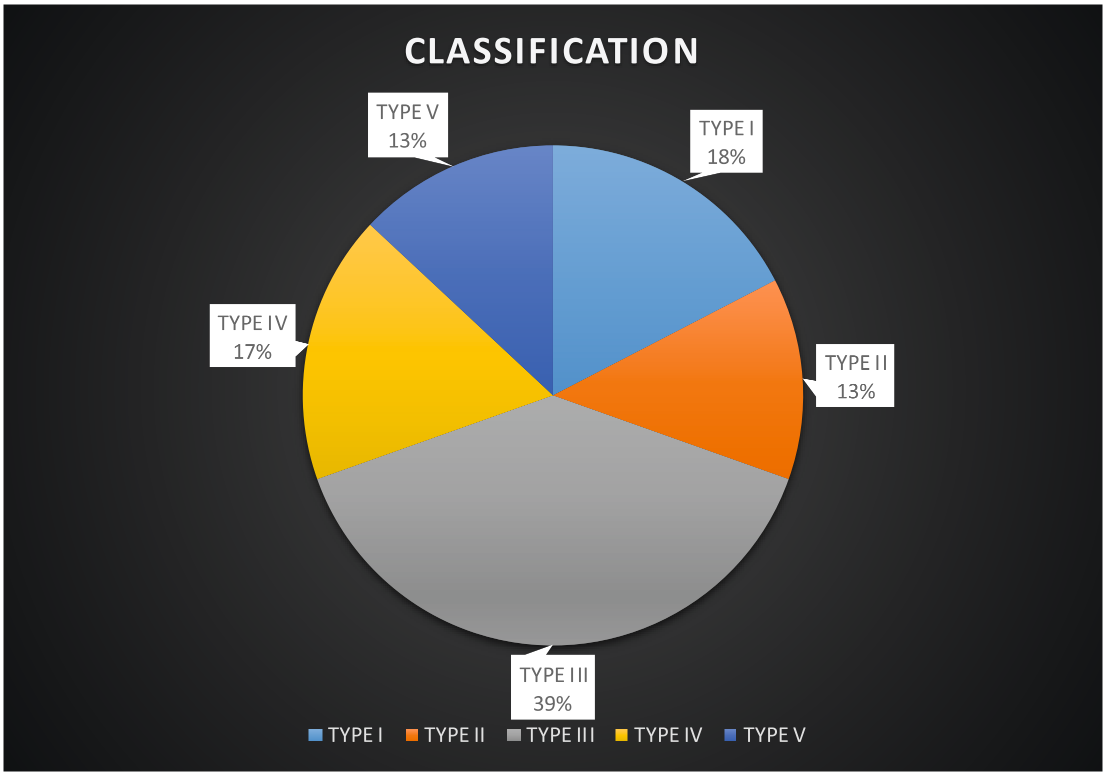
Commonest mode of injury was RTA

mode of injury	no. of cases	Percentage
RTA	14	61
Accidental fall	9	39



V. CLASSIFICATION OF FRACTURES

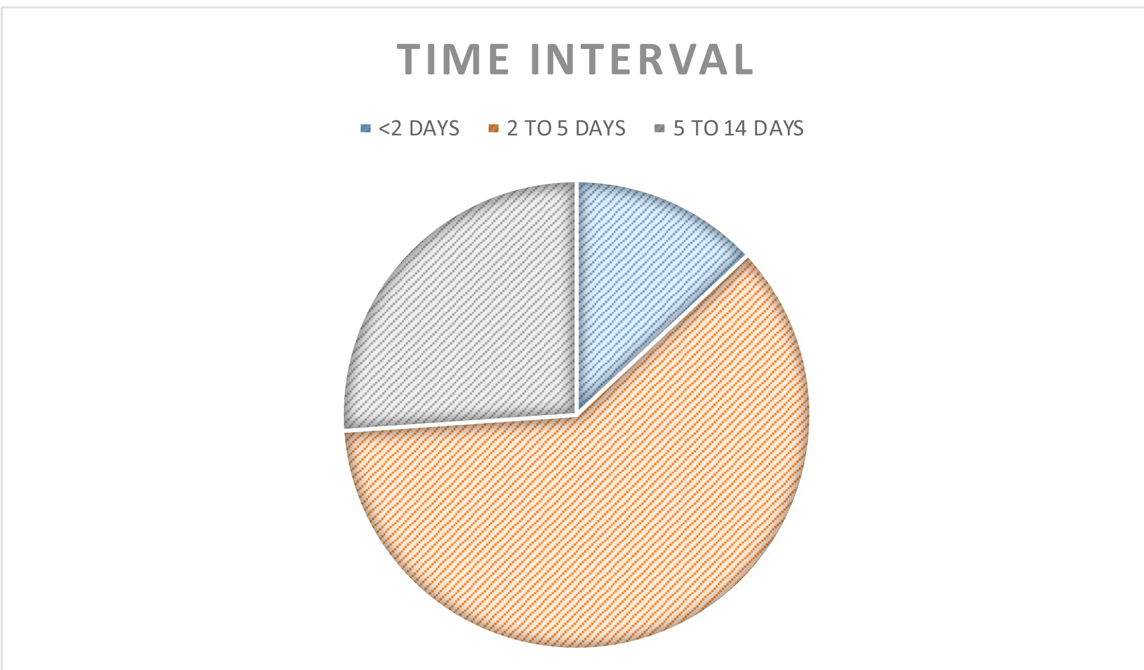
FRYKMAN CLASSIFICATION	NO. OF CASES	PERCENTAGE
TYPE I	4	17
TYPE II	3	13
TYPE III	9	40
TYPE IV	4	17
TYPE V	3	13



VI. TIME INTERVAL BETWEEN INJURY AND SURGERY

Usually the time interval between injury and surgery was 2 to 5 days.

TIME INTERVAL	NO. OF CASES	PERCENTAGE
<2 DAYS	3	13
2 TO 5 DAYS	14	61
5 TO 14 DAYS	6	26

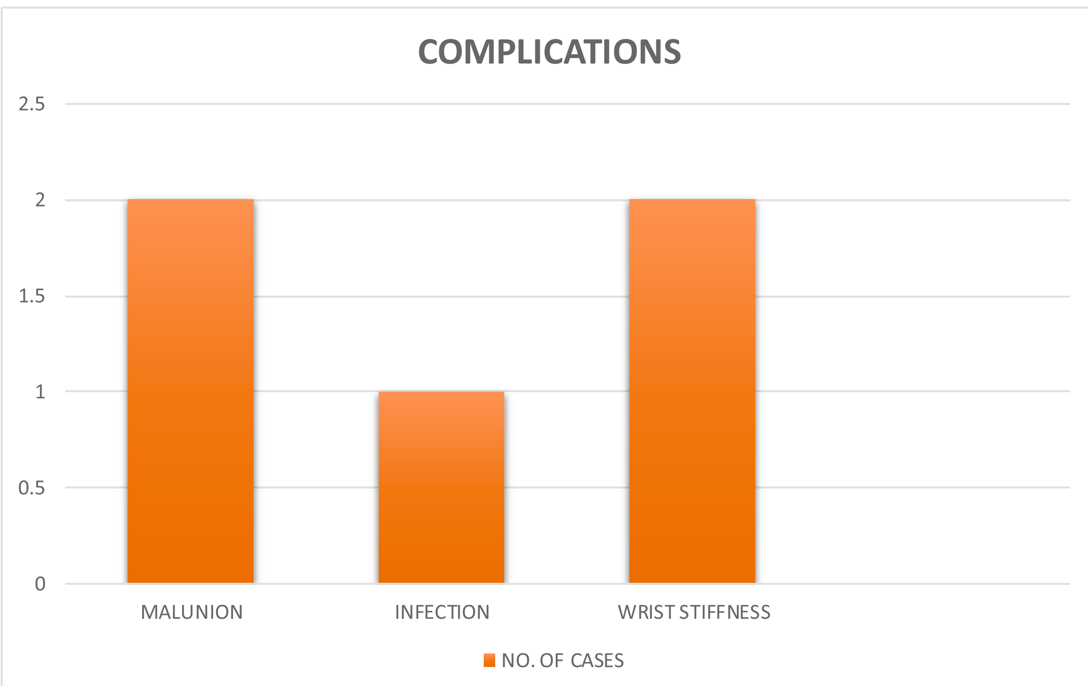


VII. ASSOCIATED INJURIES:

1. Both bone leg # - 2
2. Femur # - 1
3. Visceral organ injury – 2

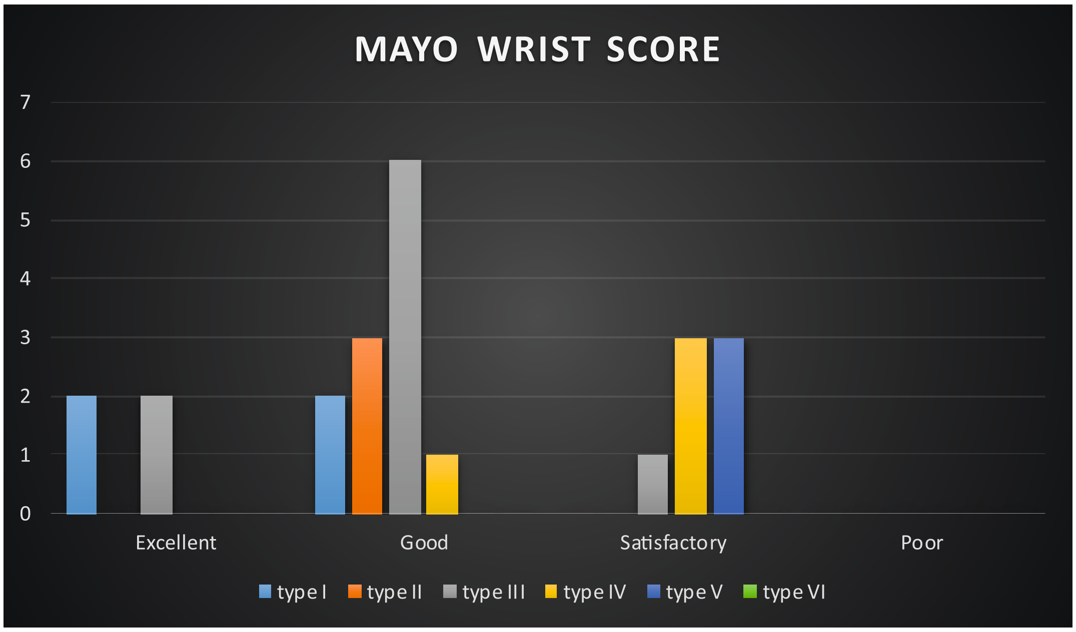
VIII. COMPLICATIONS:

COMPLICATION	NO. OF CASES
MALUNION	2
INFECTION	1
WRIST STIFFNESS	2



IX. Mayo wrist score

	Number of cases	Percentage
90 – 100	4	17.5%
80 – 90	12	52%
70 – 80	4	17.5%
60 – 70	3	13%



PROCEDURE AND POST-OPERATIVE PROTOCOL:-

Technique:

Patient in supine position in conventional table with arm extended in arm table, under regional anaesthesia, under tourniquet control, the affect limb is painted and draped.

Closed reduction of fracture done under fluoroscopy guidance. If a satisfactory reduction is possible, the fracture is provisionally fixed with k-wires inserted from the styloid process to the proximal ulnar side or in reverse direction depending on the fracture pattern. In case of comminuted fractures, more than one k-wires may be needed to maintain the reduction and articular congruity. Two skin incisions of about 2cm length were made. The position of the incision is dependent on the fracture pattern and length of the plate. In fractures within 1cm of the articular surface, a transverse incision parallel to the proximal wrist crease was chosen. In fractures more than 1cm away from the articular surface , longitudinal incision parallel to the flexor carpi radialis was made.

The flexor carpi radialis was retracted to the radial or ulnar side. Radial artery identified and retracted. Then the flexor pollicis longus was identified and retracted to expose pronator quadratus.

If reduction was satisfactory, plate was slid under the pronator quadratus through a small longitudinal incision. In case where open reduction was needed, the distal part of the muscle is incised to aid visualisation of fracture fragment and reduction.

ILLUSTRATION – SURGICAL STEPS


X-RAY OFF

Under fluoroscopy guidance, 2cm incision was made parallel to flexor carpi radialis according to the plate placement. The plate was provisionally fixed to radial shaft with a k-wire. After confirming the reduction in anteroposterior and lateral views, screws were applied in the transverse and longitudinal limbs of the plate. Stability of the fixation was verified after removing the k-wires. In some cases fixation was augmented with additional k-wires. Wound closed in layers.

Post-operative protocol:-

After surgery the limb was kept in elevated position. The timing of rehabilitation was based on

1. Fracture pattern
2. Bone quality
3. Stability of the fixation
4. Patient compliance

Second post-operative day:-

In comminuted fractures the limb was immobilized in supportive splint for the first week. In second post-op day, wound inspection was done and dressing changed. Finger, elbow and shoulder mobilization exercises were started. Exercises to maintain the tone of the finger flexors were started.

After one week, the supportive splint was removed and wrist flexion and extension exercises were started according to patients pain tolerance. Patient was advised to review on 10^{th} post operative day for suture removal. On 10th day, patients understanding and compliance with exercises were evaluated and taught accordingly.

Patient was reviewed on 4^{th} post-operative week, during which rotational movements were started. Subsequent follow-ups were done on 10^{th} week with radiological investigation to check for bony union.

Follow up:-

All the patients were followed up carefully, evaluating for any complications. After bony union, the patients were reviewed monthly upto 6 months, evaluating the outcome based on Mayo wrist scoring system.

PITFALLS AND THEIR MANAGEMENT

MALUNION:

In our study, 2 patients had malunion. One of the patient had metaphyseal comminution, which collapsed on the second week of fixation. Other patient was found to have malunion on the fourth week radiograph. Despite malunion, one of the patient had good functional outcome owing to the rehabilitation measures.

WRIST STIFFNESS:

In our study, 2 patients had stiffness of wrist joint because of poor co-operation with rehabilitation exercise. They were treated with mobilisation after heat therapy and they showed progressive improvement with rehabilitation. One of these patients had malunion and his range of movements were poor compared to other patients.

INFECTION:

In our study, one patient had minimal serous discharge from the incision site. The infection was treated according to pus culture and sensitivity report with intravenous antibiotics for a week, followed by oral antibiotics for another week. The infection subsided without any complication. Union was also not affected in this patient.

DISCUSSION:

The goal of surgery for unstable distal radius fracture is to obtain and maintain an anatomical reduction and to allow restoration of function. Achieving fracture stability is a prerequisite for attaining a satisfactory outcome for distal radius fractures.

Unstable fractures are at increased risk for loss of reduction and subsequent malunion. Malunion can potentially lead to a poor functional outcome with residual pain, loss of motion, decreased endurance and grip strength, midcarpal instability, and post-traumatic arthritis.

MIPO techniques are commonly utilised in the management of fractures of distal femur, proximal and distal tibia. In this study, we initiated MIPO technique for distal radius fracture presuming that the advantages of MIPO may improve the functional outcome.

Numerous prospective studies to evaluate the functional outcome of various treatment options including plaster immobilization, external fixation and open reduction with internal fixation. Good or excellent results were achieved in 43%, 80% and 63%in each group. Recent studies show further improvement in functional outcome of ORIF owing to advances in implants and surgical techniques.

Wright, Horodyski and Smith reported retrospective study of 21 patients treated with plating and external fixation. In this study, there was no functional difference between the two groups.

Egol, Walsh, Tejwani et:al conducted a prospective randomized study involving 88 cases. Although the patients treated by plating had significant early improvement in the range of movement of wrist, in absolute terms the difference in range of movement was clinically unimportant. At one year radiological, clinical and functional outcome were similar in two groups.

These studies attribute soft tissue preservation in external fixation to the good functional outcome with the technique, even though the radiological outcome was better in ORIF than external fixation.

However, external fixation is associated with high risk for infection and stiffness. Incidence of pin tract infection usually with staphylococcus aureus and staphylococcus epidermidis has been reported between 0.5% to 30%.

With MIPO both advantages of articular reduction with ORIF and soft tissue preservation with external fixation can be obtained. In our study, the functional outcome with Mayo wrist score was comparable to the results reported with conventional plating and external fixation.

Further,in our study only one patient developed mild infection which is much lower compared to the external fixator.

Nerve injury, commonly median nerve injury has been reported with incidence of 0-17% in conventional plating technique. In our study no neurovascular injuries had occurred, since the incision were made on safety zones considering the neurovascular anatomy.

In our study malunion was reported in 2 cases. Both patients had higher comminution (Frykman classification type 5) which indicates that MIPO is not suitable for all distal radius fractures. Proper selection of patients according to the fracture characteristics will certainly decrease this complication.

Average flexion and extension arc has been found to be 102 and supination/pronation arc to be 154 degrees. (Fituossi et:al average 112 degree flexion and extension arc) . (Rozental and Blazer 52 degree flexion, 53 degree extension, 71 degree supination and 73 degree pronation).

Operating time and radiation exposure is not significantly higher when compared to the conventional plating technique.

The limitation of this study includes small study group, short follow up period and absence of control group.

OBSERVATION:

The conclusions of this study are

- The distal radius fracture is a common fracture encountered in orthopaedic trauma centre.
- Due to increased incidence of the road traffic accidents (high velocity injury) distal radius fracture in young patient is increasing.
- The technique of minimally invasive plate osteosynthesis can be utilised in extra articular and minimally comminuted intra articular fractures.
- **The advantages of MIPO for distal radius are:**
    a) Preserve the soft tissue attachments and aids in good union
    b) Attrition of flexor tendons avoided
    c) Preservation of blood supply
    d) Better range of movements
    e) Better cosmetic outcome
    f) Decrease in hospital stay
- An adequate surgical technique will minimize complications and a personalised rehabilitation regime will ensure the best possible result. The surgeon's familiarity with the technique and instruments also plays an important role. Accurate anatomical reduction of the articular surface and stable fixation are mandatory for better functional outcome.

CONCLUSION:

- The results of minimally invasive plate osteosynthesis are comparable to conventional plating technique.
- Minimally invasive plate osteosynthesis can be utilised for extra articular distal radius fracture and with minimal articular involvement.
- It avoids extensive soft tissue dissection, provides rigid fixation, allows early mobilisation, provides better functional and cosmetic outcome and decreases the duration of hospital stay.

CASE I

PRE OP

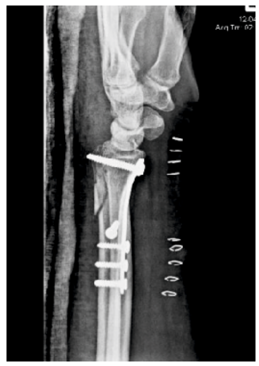
IMMEDIATE POST OP

FOLLOW UP

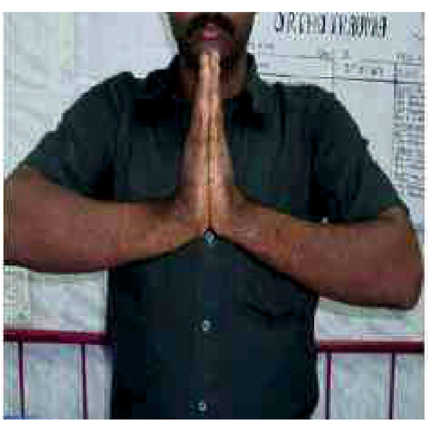
CASE II

PRE OP

IMMEDIATE POST OP



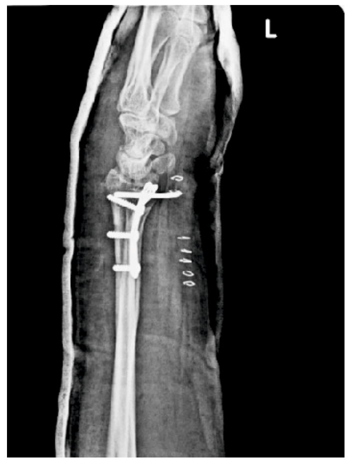
FOLLOW UP



CASE III

PRE OP

IMMEDIATE POST OP



FOLLOW UP

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MASTER CHART

S. No	Name	Age/ sex	IP No	Diagnosis	Procedure	Complication	MAYO Wrist score	Results	Associated injury	Mode of injury
1	Parvathy	37/f	48299	Frykman type III # Rt distal radius	MIPO	Nil	92	Excellent	Nil	Accidental fall
2	Vadivelu	43/m	48574	Frykman type IV # Lt distal radius	MIPO	Nil	79	Satisfactory	Nil	RTA
3	Palani	58/f	71256	Frykman type I # Lt distal radius	MIPO	Nil	86	Good	Nil	Accidental fall
4	Sethu Ramalingam	60/m	2795	Frykman type I # Rt distal radius	MIPO	Nil	84	Good	Nil	Accidental fall
5	Chelladurai	46/m	14173	Frykman type IV # Rt distal radius	MIPO	Nil	68	Satisfactory	# both bone leg	RTA
6	Balasubramanian	50/m	14501	Frykman type III # Lt distal radius	MIPO	Nil	81	Good	Nil	RTA
7	Esakkiammal	48/f	16456	Frykman type II # Rt distal radius	MIPO	Nil	88	Good	Nil	Accidental fall
8	Ganapathy Thayappan	55/m	17305	Frykman type V # Lt distal radius	MIPO	#collapse / stiffness	79	Satisfactory	Nil	Accidental fall
9	Nijam	20/m	23010	Frykman type III # Lt distal radius	MIPO	Nil	89	Good	Nil	RTA
10	Esakkiappan	45/m	25033	Frykman type III # Lt distal radius	MIPO	Nil	90	Excellent	Nil	RTA
11	Esakkiammal	33/f	35431	Frykman type IV # Rt distal radius	MIPO	Nil	82	Good	Nil	RTA

12	Sankaravadivoo	47/m	39751	Frykman type I # Rt distal radius	MIPO	Nil	92	Excellent	Nil	Accidental fall
13	Madasamy	26/m	41433	Frykman type V # Rt distal radius	MIPO	Malunion	64	Satisfactory	Nil	RTA
14	Rajan	49/m	41976	Frykman type II # Lt distal radius	MIPO	Nil	87	Good	Nil	RTA
15	Albert	21/m	48215	Frykman type III # Lt distal radius	MIPO	Nil	86	Good	# shaft of Rt femur, # BB Rt leg	RTA
16	Mohammed Ibrahim	48/m	90	Frykman type IV # Rt distal radius	MIPO	Wrist stiffness	70	Satisfactory	Haemothorax	RTA
17	Vallavan	27/m	879	Frykman type III # Rt distal radius	MIPO	Nil	87	Good	Nil	RTA
18	Maridurai	56/m	9907	Frykman type V # Lt distal radius	MIPO	Infection	71	Satisfactory	Nil	Accidental fall
19	Karuppasamy	30/m	9196	Frykman type III # Lt distal radius	MIPO	Nil	84	Good	Head injury	RTA
20	Balamurugan	24/m	14375	Frykman type II # Rt distal radius	MIPO	Nil	89	Good	Nil	RTA
21	Ashok Kumar	26/m	17417	Frykman type III # Rt distal radius	MIPO	Nil	81	Good	Nil	RTA
22	Dulachimani	39/f	17121	Frykman type III # Lt distal radius	MIPO	Nil	78	Satisfactory	Nil	Accidental fall
23	Palani	47/f	36231	Frykman type I # Rt distal radius	MIPO	Nil	91	excellent	Nil	Accidental fall